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Yield Performance of Rice *(Oryza sativa* L.) Varieties in Direct Seeded Condition under Organic Farming

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Field experiments were conducted during *rainy* seasons of 2018 to 2020 at Regional Rice Research Station, Navsari Agricultural University, Vyara, Gujarat on clayey soils. The treatment consists of four rice varieties *i.e*., Purna, GR 5, GNR 6 and IR 28 with 100 % and 50 % recommended dose of N through FYM. Result showed that significantly higher plant height recorded in variety GR 5 which was at par with variety Purna. Highest panicle m^{-2} were recorded in variety Purna followed by GR 5. Significantly higher grain yield was recorded in variety Purna which was statistically at par with variety GR 5. Significantly higher straw yield was recorded in variety GR 5 which was statistically at par with variety Purna. The treatment consists of application of 100% and 50% recommended dose of Nitrogen through farmyard manure recorded non significant difference. Hence, farmers of south Gujarat, growing direct seeded upland rice (Purna or GR 5) organically are needs to apply 37.5 kg N ha^{-1} (50% recommended dose of Nitrogen) through farmyard manure for achieving profitable yield.

Keywords: Variety; organic farming; rice; economics.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food of more than 60% population of India which occupies an area of 43.78 million hectare with production of 118.43 million tonnes and the average productivity is 2705 kg ha^{-1} [1]. In Gujarat, rice is cultivated on an area of 9.03 lakh hectares with the production of 21.46 lac tonnes and productivity 2374.69 kg ha^{-1} [2]. Rice is grown

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mostly through direct dry seeding, direct wet seeding and transplanting. Transplanting after repeated puddling is the conventional method of rice growing is not only water intensive but also cumbersome and laborious. Different problems like lowering water table, scarcity of labour during peak periods, deteriorating soil health demands some alternative establishment method to sustain productivity of rice as well as natural resources. Direct seeded rice, probably the oldest method of crop establishment, is gaining popularity because of its low input demand. It offers certain advantages *viz*., saves labour, requires less water, less drudgery, early crop maturity, low production cost, better soil physical conditions for following crops. Comparative yields in direct seeded rice can be obtained by adopting various cultural practices *viz*., selection of suitable cultivars, proper sowing time, optimum seed rate, proper weed, water and fertilizer management. The use of chemical fertilizers is the quickest and surest way of boosting rice crop production. However their cost and increase use in crop production deteriorates soil health, cause health hazard and insecurity of quality food. Energy crisis, higher fertilizer cost, sustainability in agri production system and ecological stability are the important issues which renewed the interest of farmers and research workers in non-chemical sources of plant nutrients like green manure, farmyard manure, bio compost and biofertilizes etc. Upland drilled rice growing on natural precipitation without any source of irrigation. Very limited information available on suitable varieties for organic farming and nutrient management of upland rice crop grown organically and optimum amount of organic fertilizer in form of farmyard manure required to grow good upland rice crop in sustainable and economic viable manner. Hence an attempt was made to find out suitable varieties in direct seeded condition and optimum dose of farmyard manure.

2. MATERIALS AND METHODS

The Experiment was conducted at Regional Rice Research Station, Navsari Agricultural University, Vyara, Gujarat during *rainy* seasons *of* 2018 to 2020 under direct seeded condition. The soil of experimental site was clayey in texture with available nitrogen (288.3 kg ha^{-1}), available P (37.3 kg ha^{-1}) and available K (292.1 kg ha^{-1}) with soil pH of 7.28. The site utilized for this experiment was converted organic since 2015. Recommended N dose for upland rice was 75 kg ha^{-1}.The experiment was laid out in randomized block design with factorial concept and four replications. Treatments consisted of four rice varieties *i.e*., Purna, GR 5, GNR 6 and IR 28 with 100 % and 50 % recommended dose of N through farmyard manure. Treatment of nutrient in form of farmyard manure applied as basal. To know the initial and after harvest nutrient status of the soil, soil samples were collected from the experimental plot area. These samples were air dried, ground and passed through 2 mm sieve and were analyzed for nutrient status by adopting electrical conductivity meter method for soil Ec, pH meter method for soil pH, walkley and black method for organic carbon, Olsen's method for available phosphorus and Flame photometric method for available potash. The crop was sown in direct seeded condition between 30 cm spacing between rows. The total rainfall received during the cropping period was 1442, 1998 and 1984 mm in 45, 85 and 56 rainy days during rainy seasons of 2018, 2019 and 2020 respectively. Crop condition was good during all the three years and all cultural operation performs timely to raise good crop.

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Attributes

Pooled analysis of plant height data for different varieties of direct seeded condition found to be significant. Result showed that significantly higher plant height (114.7 cm) recorded in variety GR 5 which was at par with variety Purna (112.3 cm). It may be due to the genetic character of the variety and higher photosynthesis efficiency [3,4]. The results consistent with the findings of [5,6,7,8], who observed plant height, differed significantly among the varieties. But numerically higher number of panicle m^{-2} (143) were recorded in variety Purna followed by GR 5 (Table 1). Variation in number of panicle m^{-2} might be due to differences in genetic makeup of these rice varieties. Similar trends were also found by Mahmud et al. [9] who showed that rice varieties differed significantly in all growth characters especially tillers number. Plant height and number of panicle m^{-2} data showed non-significant difference among application of farmyard manure in pooled analysis. 100% recommended dose of Nitrogen through farmyard manure showed 140.4 panicle m^{-2} whereas, 50% recommended dose of Nitrogen through farmyard manure recorded 134.3 panicle m^{-2}. Interaction effect of Variety and farmyard manure was found non significant on pooled basis.

3.1.1 Grain yield

Under organic farming yield performance of rice varieties in direct seeded condition was found to significant for three seasons and on pooled basis. Significantly higher grain yield of 2393 kg ha^{-1} was recorded in variety Purna which was statistically at par with variety GR 5, yielded 2031 kg ha^{-1} (Table 1). Lowest grain yield was recorded in variety GNR 6 in pooled analysis. Further, grain yields of rice directly correlated to the number of panicle m^{-2}. These yield attributing characters were significantly superior in Purna as compared to GR 5, IR 28 and GNR 6, which attributed to produce higher grain yield. Similar results have also been obtained by Archana [10] and Gawali et al. [11] who reported grain and straw yield of wheat was affected significantly by the different varieties. Application of organic source through farmyard manure was found non significant difference for grain yield data on pooled basis. Interaction effect of Variety and farmyard manure was found non significant on pooled basis. Farmyard manure applied at 100% and 50% recommended dose of nitrogen recorded 1946 kg ha^{-1} and 1877 kg ha^{-1} grain yield, respectively.

3.1.2 Straw yield

The straw yield data revealed that performance of rice varieties in direct seeded condition was found to significant for three season and on pooled basis. Significantly higher straw yield of 3609 kg ha^{-1} was recorded in variety GR 5 which was statistically at par with variety Purna, yielded 3598 kg ha^{-1} (Table 1). The highest straw yield in GR 5 might be due to higher plant growth associated with poor dry matter partitioning to sink. The result agree to find of [12,13].

Table 1. Effect of rice varieties and level of organic fertilizer on growth attributes, grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and economics (pooled data of three years)

Treatment	Plant height (cm)	No. of panicle m^{-2}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Total income (Rupees ha^{-1})	Total cost (Rupees ha^{-1})	Net income (Rupees ha^{-1})	Benefit cost ratio (Rupees ha^{-1})
Varieties								
V_1 : Purna	112.3	142.9	2393	3598	48488	30104	18384	1.61
V_2 : GR 5	114.7	140.8	2031	3609	43097	30104	12993	1.43
V_3 : IR 28	79.0	133.4	1657	2597	33945	30104	3841	1.13
V_4 : GNR 6	87.2	132.3	1566	2627	32685	30104	2581	1.09
S Em ±	3.56	3.86	208.25	105.44	-	-	-	-
CD at 5%	12.33	NS	720.65	298.07	-	-	-	-
Level of organic fertilizer								
M_1: 100% recommended dose of Nitrogen through Farmyard manure	98.2	140.4	1946	3215	40443	32104	8339	1.26
M_2: 50% recommended dose of Nitrogen through Farmyard manure	98.4	134.3	1877	3000	38655	30104	8551	1.28
S Em ±	1.14	2.73	36.15	74.55	-	-	-	-
CD at 5%	NS	NS	NS	298.07	-	-	-	-
Interaction effect								
S Em ±	1.02	5.56	46.10	71.38	-	-	-	-
CD at 5%	NS	NS	NS	NS	-	-	-	-
CV %	8.04	13.76	13.4	17.02	-	-	-	-

Note: 1) Price of paddy grain: 15 Rupees Kg^{-1} 2) Price of straw: 3.5 Rupees Kg^{-1}

Table 2. Effect of rice varieties and level of organic fertilizer on soil electrical conductivity, pH, organic carbon, available phosphorus and available potash after harvest of crop

Treatment	Electrical conductivity	pH	Organic carbon (%)	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Varieties					
V_1 : Purna	0.30	7.31	0.68	40.8	285.9
V_2 : GR 5	0.32	7.37	0.56	41.9	287.8
V_3 : IR 28	0.31	7.28	0.71	40.9	284.0
V_4 : GNR 6	0.32	7.39	0.54	42.6	280.3
S Em ±	0.016	0.049	0.017	1.50	2.39
CD at 5%	NS	NS	0.051	NS	NS
Level of organic fertilizer					
M_1: 100% recommended dose of nitrogen through farmyard manure	0.33	7.32	0.61	41.2	284.9
M_2: 50% recommended dose of nitrogen through farmyard manure	0.30	7.36	0.63	41.9	284.1
S Em ±	0.011	0.0347	0.012	1.06	1.69
CD at 5%	NS	NS	NS	NS	NS
Interaction effect					
S Em ±	0.022	0.0693	0.025	2.12	3.39
CD at 5%	NS	NS	NS	NS	NS
CV %	14.37	1.89	7.93	10.21	2.38

Application of 100% recommended dose of nitrogen (kg ha^{-1}) through farmyard manure recorded highest straw yield of 3215 kg ha^{-1} which was statistically at par with 50% recommended dose of nitrogen (kg ha^{-1}) yielded 3000 kg ha^{-1}. Adequate nutrient availability contributed to better growth parameters and yield attributes. Similar results were also reported by Sharma et al. [14]. Interaction effect of variety and farmyard manure was found non significant on pooled basis.

3.2 Soil Parameter

The data pertaining to soil fertility in terms of organic carbon (%), available P_2O_5 (kg ha^{-1}) and available K_2O (kg ha^{-1}) are summarized in table 2. Different varieties had their significant effect on organic carbon (%) in soil. Regarding the effect of different varieties on available Phosphorus and available Potash after harvest of crop in soil had non significant effect. Application of organic source through farmyard manure was found non significant difference on soil parameters *viz.*, Ec, pH, organic carbon, available P_2O_5 and available K_2O. Interaction effect of variety and farmyard manure was found non significant.

3.3 Economics

Economics (Table 1) show that treatment V_1 (Purna) accured the higher net return (Rs. 18384 ha^{-1} and Benefit cost ratio 1.61) closely followed by treatment V_2 (GR 5) (net return Rs. 12993 ha^{-1} and Benefit cost ratio 1.43). This might be due to higher grain yield under this treatment.

4. CONCLUSION

Farmers of South Gujarat, growing rice organically are advised to cultivate direct seeded rice varieties Purna or GR 5 with 50% recommended dose of nitrogen (37.5 kg N ha^{-1}) through farmyard manure on basis of nutrient content for achieving profitable yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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