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# Effect of dry seeding of *Kharif* rice (*Oryza sativa* L.) varieties to different fertilizer levels on yield and nutrient (NPK) content, available nutrient (NPK) in soil and nutrient (NPK) uptake

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**Abstract**
The agronomic investigation was undertaken at Post Graduate Research Farm, Agronomy Section of Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur (M.S.), India during *kharif*, 2019. The experiment was laid out in a split plot design with four replications and nine treatment combinations comprising of three varieties of rice $V_1$- Indrayani, $V_2$- Phule Radha and $V_3$- Bhogawati as main plot treatments and three fertilizer levels $F_1$- 75% RDF, $F_2$- 100% RDF and $F_3$- 125% RDF as sub plot treatments on sandy clay loam soil. The variety Indrayani had the higher grain yield (59.50 q ha$^{-1}$), straw yield (86.75 q ha$^{-1}$) and harvest index (40.62%) which were statistically at par with Bhogawati and superior over Phule Radha. Grain yield (58.83 q ha$^{-1}$), straw yield (87.73 q ha$^{-1}$) and harvest index (40.06%) were also significantly maximum with the application of 125% RDF ha$^{-1}$ which was at par with application of 100% RDF ha$^{-1}$ and significantly superior over 75% RDF ha$^{-1}$. The effect of interaction between rice varieties and fertilizer levels were significantly influenced the yield attributing characters. The rice variety Indrayani when applied with 125% RDF ha$^{-1}$ exhibited significantly superior grain yield (64.62 q ha$^{-1}$), straw yield (92.25 q ha$^{-1}$) and harvest index (41.18%) over rest of all the remaining interaction combinations. The content of N, P and K in grain were (1.24%, 0.31% & 0.14%) and straw (0.78%, 0.19% & 1.49%) respectively, total uptake of nutrients were (142.66, 35.85 & 138.56 NPK kg ha$^{-1}$) respectively by rice crop were found significantly maximum with the variety Indrayani followed by Bhogawati and which was superior over Phule Radha. Available N, P and K were (268.09, 36.42 & 277.17 NPK kg ha$^{-1}$) respectively in soil after harvest was found significantly maximum with the variety Phule Radha followed by Bhogawati which was superior over Indrayani. The content of N, P and K in grain were (1.29%, 0.31% & 0.14%) and straw (0.79%, 0.20% & 1.49%) respectively, total uptake of nutrients were (146.35, 36.85 & 140.19 NPK kg ha$^{-1}$) respectively by rice crop and available N, P and K were (267.24, 37.22 & 289.91 NPK kg ha$^{-1}$) respectively in soil after harvest were found significantly maximum with the application of 125% RDF ha$^{-1}$ which was at par with application of 100% RDF ha$^{-1}$ and significantly superior over 75% RDF ha$^{-1}$.

**Keywords:** variety, fertilizer levels, yield, nutrient content, nutrient uptake, available nutrient

## Introduction
Rice is the staple food for 2.5 billion people and it covers about 9% of the earth's arable land. Rice provides 21% of global human per capita energy and 15 percent of per capita protein. Asia accounts for over 90% of the world's production of rice, with China, India and Indonesia are leading countries. The worldwide rice production in 2019-20, China was the leading country with a production of 146.73 million metric tonnes followed by India with 115.00 million metric tonnes (Anonymous, 2020) [2]. Rice is cultivated in India in a very wide range of ecosystems from irrigated to shallow lowlands, mid-deep lowlands, and deep lowlands to uplands. Transplanting is the major method of rice cultivation in India. However, transplanting is becoming increasingly difficult due to shortage and high cost of labour, scarcity of water, and reduced profit. Thus, direct seeding is gaining popularity among farmers of India as in other Asian countries. Direct-seeding constitutes both wet and dry seeding and it does away with the need for seedlings, nursery preparation, uprooting of seedlings and transplanting. In Sub Montane Zone of Maharashtra and especially in Kolhapur district, it is mostly grown by transplanted method; however, there are some of the pockets, where direct seeding and dibbling is practiced. In the sub-montane zone of Maharashtra and especially in Kolhapur district, there are several rice cultivars developed by the Agriculture University and Private Seed Companies which are used by the local farmers for puddle transplanted rice cultivation.

But, there are no any cultivar developed for dry seeded condition and for other direct seeding methods under rainfed condition. Short and medium duration rice varieties should be preferred for dry direct seeded condition. The promising and popular varieties famous among the farmers developed by Agriculture University are therefore selected to study the yield potential for different fertilizer doses in dry direct seeded rice cultivation. The research study will be helpful for choosing the suitable varieties and fertilizer doses for getting higher optimum yield in dry seeding condition. Major rice growing areas in the region are highly sandy clay loams. Poor fertility and low moisture holding capacity are the characteristics of these soils. Fertilizer input is one of the major determinants of the profitability of the rice grown on these soils. Fertilizer use efficiency is low in the region due to heavy rainfall and it is revealed from the studies that use of different fertilizers improves fertilizer use efficiency (Tondon, 1992) [24]. The information on nutrient requirements of the crop to be supplied through straight fertilizers is available. However, the information on requirement of nutrients in rice established by comparing different fertilizer sources is lacking. Thus, farmers' adoption for a variety becomes different as the performance of the variety under suboptimal nutrient conditions is least as important as their performance under optimal nutrient supplies.

## Materials and Methods

### Experimental details

The experiment was laid out in a split plot design with four replications and nine treatment combinations comprising of three varieties $V_1$- Indrayani, $V_2$- Phule Radha and $V_3$- Bhogawati as main plot treatments and three fertilizer levels $F_1$- 75% RDF, $F_2$- 100% RDF and $F_3$- 125% RDF as sub plot treatments. The gross and net plot size were 6.00 m x 4.5 m and 5.00 m x 3.6 m, respectively. A spacing of 22.5 cm was adopted in seed sowing between two rows. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 7.70), having electrical conductivity 0.28 dS $m^{-1}$ and organic carbon content was very low (0.18%), low in available nitrogen (254.90 kg $ha^{-1}$), medium in available phosphorus (28.70 kg $ha^{-1}$) and high in available potassium (276.20 kg $ha^{-1}$).

The crop was sown on 3rd of June, 2019 by line sowing method with different varieties and fertilizer levels. The rice crop was fertilized treatment wise as per different fertilizer levels. The fertilizers were applied at the time of sowing of rice seed, 40 per cent nitrogen, and full dose of $P_2O_5$ and of $K_2O$ was applied as basal dose. The remaining 60 per cent nitrogen was applied in two splits; 40 per cent at maximum tillering stage i.e. 30 DAS and 20 per cent at 60 DAS. Nitrogen was applied through urea (46% N), $P_2O_5$ through Diammonium phosphate (18:46:00), $K_2O$ through Muriate of Potash (60% $K_2O$).

**Plant analysis:** The sample from different plant parts of observational plants were used for chemical estimation of total nitrogen, phosphorus and potassium. The concentration of nitrogen in plant and grain was estimated by Micro Kjeldhal method. The phosphorus was determined by Calorimetric method (Jackson, 1973) [5] and potassium was estimated by flame photometer method.

**Collection, preparation and digestion of Plant Samples**

The plant samples collected after harvest were cleaned shade dried and then dried in hot air oven at 65 $^0$C. Further, these samples were milled to considerable fineness in a mill and stored in plastic bags for further analysis. The powdered plant sample 0.5 g passed through 100 mm sieve was pre-digested with concentrated nitric acid overnight. Further, pre-digested samples were treated with tri-acid (nitric acid: sulphuric acid: perchloric acid in ratio 9:1:4) mixture and kept on sand bath for digestion. After complete digestion the precipitate was dissolved in 6 N HCl and Transferred to the 100 ml volumetric flask through Whatman No. 42 filter paper by thoroughly washing with double distilled water and finally the volume was made to 100 ml and preserved for further analysis.

**Nitrogen (N) content estimation:** The powdered 0.5 g plant sample was digested with concentrated sulphuric acid and digestion mixture ($CuSO_4$ + $K_2SO_4$ + selenium powder). The digest was transferred to the micro kjeldhal distillation flask and the ammonia liberated was distilled in presence of alkali collected in 2 per cent boric acid and the distillate was titrated against standard acid (Jackson, 1973) [5].

**Phosphorous (P) content estimation:** The phosphorus in plant sample was determined by Vanado molybdateoposphoric yellow colour method (Jackson, 1973) [5].

**Potassium (K) content estimation:** The potassium content in the digested samples was determined by flame photometer after making appropriate dilution (Jackson, 1973) [5].

**Uptake studies:** The uptake of nitrogen, phosphorus and potassium (kg $ha^{-1}$) was worked out by multiplying the percentage of these nutrients in grain, straw with the corresponding yields of the respective constituent.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient conc. (\%) x Wt. of dry matter (kg ha}^{-1})}{100}$$

**Statistical analysis:** The statistical analysis of split plot design with 4 replications, 3 main plot treatments and 3 sub-plot treatments was done by standard procedures suggested by Panse and Sukhatme (1967) [15].

## Result and Discussion

### I) Effect on yield of rice and available nutrient (NPK) in soil of rice crop

### A. Effect of varieties

The rice variety Indrayani had the higher grain yield (59.50 q $ha^{-1}$), straw yield (86.75 q $ha^{-1}$) and harvest index (40.62%) which were statistically at par with Bhogawati and superior over Phule Radha. These findings were in conformity with earlier reported by Patel and Mishra (2015) [16], Jana *et al*., (2017) [8], Kumar *et al*., (2017) [11] and Anand *et al.*, (2018) [1]. While the variety Phule Radha recorded significantly maximum mean available soil nutrients (NPK) after harvest and which was remained at par with the variety Bhogawati (257.35 kg $ha^{-1}$). The variety Indrayani recorded significantly minimum mean available soil nutrients (NPK) after harvest. Similar results were reported by Kumar *et al*., (2017) [11] and Riste *et al*., (2017) [18].

### B. Effect of fertilizer levels

Grain yield (58.83 q $ha^{-1}$), straw yield (87.73 q $ha^{-1}$) and harvest index (40.06%) were also significantly maximum with

the application of 125% RDF ha$^{-1}$ which was at par with application of 100% RDF ha$^{-1}$ and significantly superior over 75% RDF ha$^{-1}$. However, Sarker *et al.* (2013) [19], Murthy *et al.*, (2015) [14], Patel and Mishra (2015) [16], Riste *et al.*, (2017) [17], Kumar *et al.*, (2017) [11], Anand *et al.*, (2018) [1] and Grace *et al.*, (2018) [4] reported that yield of rice increased by the application higher doses of fertilizers.

However, application of 125% RDF recorded significantly the higher mean available soil nutrients (NPK) as compared to rest of the fertilizer levels after harvest and which was at par with the application 100% RDF. The significantly lowest mean available soil nutrients (NPK) recorded with the application of 75% RDF. Nitrogen availability increases with higher doses of applied nitrogenous fertilizers. These findings were in conformity with earlier reported by Ghorpade, (2015) [3], Murthy *et al.*, (2015) [14], Kumar *et al.*, (2017) [11], Riste *et al.*, (2017) [17], Jain *et al.*, (2018) [7] and Mahto *et al.*, (2018) [12].

### C. Interaction effect

The interaction effect between the varieties and the fertilizer levels was found significant in respect of yield of rice at harvest. The rice variety Indrayani when applied with 125% RDF ha$^{-1}$ exhibited significantly superior in grain yield (64.62 q ha$^{-1}$), straw yield (92.25 q ha$^{-1}$) and harvest index (41.18%) over rest of all the remaining interaction combinations. These findings were collaborative with the earlier reported by Kumar *et al.*, (2007) [10], Khaled *et al.*, (2014) [9], Suryavanshi (2015) [23] and Kumar *et al.*, (2017) [11].

While the interaction effect between the varieties and the fertilizer levels was found non-significant in respect of available soil nutrients (NPK) of rice after harvest.

**Table 1:** Yield of rice and available nutrient (NPK kg ha$^{-1}$) at harvest as influenced by different treatments

| Treatments | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Harvest Index (%) | Available nitrogen (kg ha$^{-1}$) | Available phosphorous (kg ha$^{-1}$) | Available potassium (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|
| **Main plot: Rice varieties** | | | | | | |
| $V_1$- Indrayani | 59.50 | 86.75 | 40.62 | 246.62 | 32.76 | 270.41 |
| $V_2$- Phule Radha | 48.23 | 80.12 | 37.44 | 268.09 | 36.42 | 287.18 |
| $V_3$- Bhogawati | 57.25 | 84.67 | 40.31 | 257.35 | 35.36 | 277.17 |
| S. Em± | 0.87 | 0.80 | - | 4.27 | 0.83 | 4.56 |
| C. D. at 5% | 3.01 | 2.79 | - | 14.77 | 2.86 | 14.89 |
| **Sub plot: Fertilizer levels** | | | | | | |
| $F_1$ - 75% RDF | 48.83 | 77.73 | 38.39 | 248.37 | 31.40 | 265.03 |
| $F_2$ -100% RDF | 57.32 | 86.09 | 39.91 | 256.44 | 35.92 | 279.82 |
| $F_3$ - 125% RDF | 58.83 | 87.73 | 40.06 | 267.24 | 37.22 | 289.91 |
| S. Em± | 0.77 | 0.75 | - | 4.98 | 0.61 | 6.12 |
| C. D. at 5% | 2.29 | 2.22 | - | 14.81 | 1.81 | 21.07 |
| General mean | 54.99 | 83.85 | 39.46 | 257.35 | 34.85 | 278.25 |

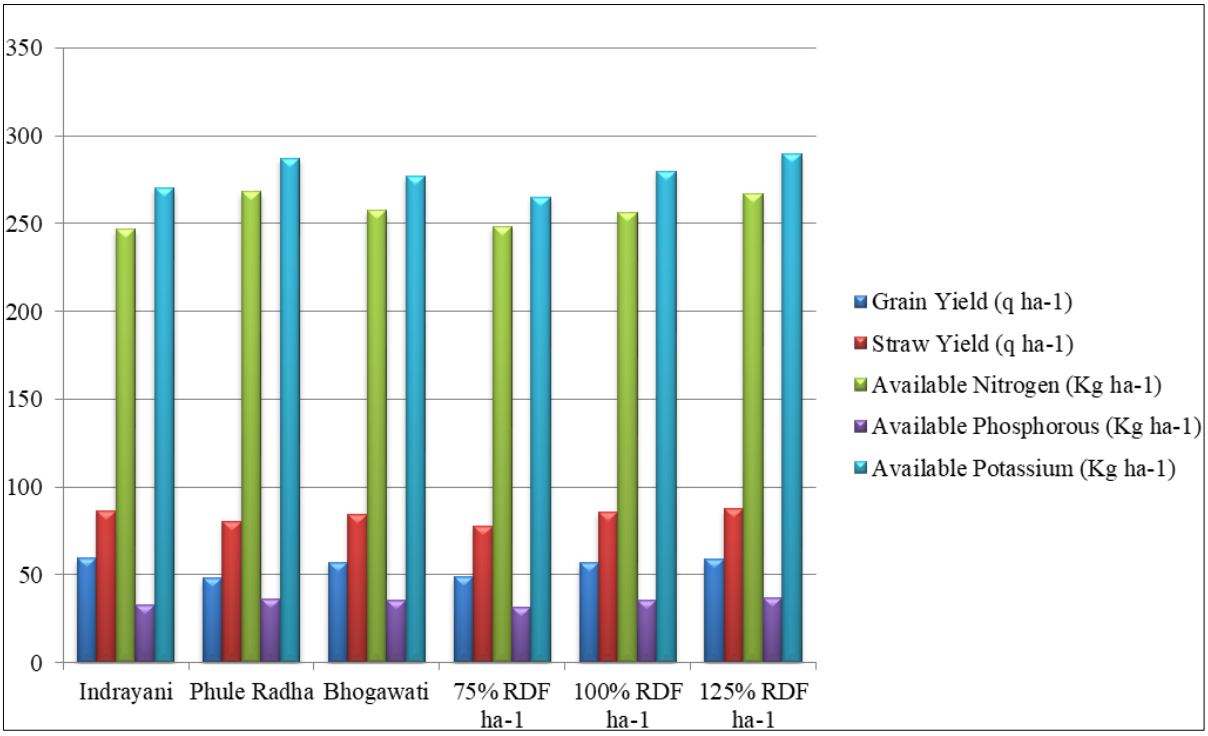


**Fig 1:** Yield of rice and available nutrient (NPK) in soil of rice crop at harvest as influenced by different treatments

**Table 2:** Effect of interaction on yield of rice and available nutrient (NPK kg ha$^{-1}$) at harvest

| Treatment combinations | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Harvest Index (%) | Available nitrogen (kg ha$^{-1}$) | Available phosphorous (kg ha$^{-1}$) | Available potassium (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|
| $V_1F_1$ | 53.26 | 80.21 | 39.85 | 233.93 | 28.49 | 261.67 |
| $V_1F_2$ | 60.63 | 87.82 | 40.84 | 248.83 | 34.31 | 269.27 |
| $V_1F_3$ | 64.62 | 92.25 | 41.18 | 257.10 | 35.51 | 280.29 |
| $V_2F_1$ | 39.79 | 71.99 | 35.59 | 264.58 | 31.46 | 268.08 |
| $V_2F_2$ | 52.41 | 84.26 | 38.33 | 267.72 | 37.99 | 293.55 |
| $V_2F_3$ | 52.52 | 84.13 | 38.42 | 271.97 | 39.81 | 299.91 |
| $V_3F_1$ | 53.47 | 81.00 | 39.74 | 246.62 | 34.27 | 265.34 |
| $V_3F_2$ | 58.93 | 86.21 | 40.58 | 252.77 | 35.47 | 276.65 |
| $V_3F_3$ | 59.36 | 86.81 | 40.60 | 272.67 | 36.34 | 289.53 |
| S. Em± | 1.34 | 1.30 | - | 8.63 | 1.05 | 2.24 |
| C. D. at 5% | 3.97 | 3.85 | - | NS | NS | NS |
| General mean | 334.02 | 23.06 | 183.99 | 257.35 | 34.85 | 278.25 |

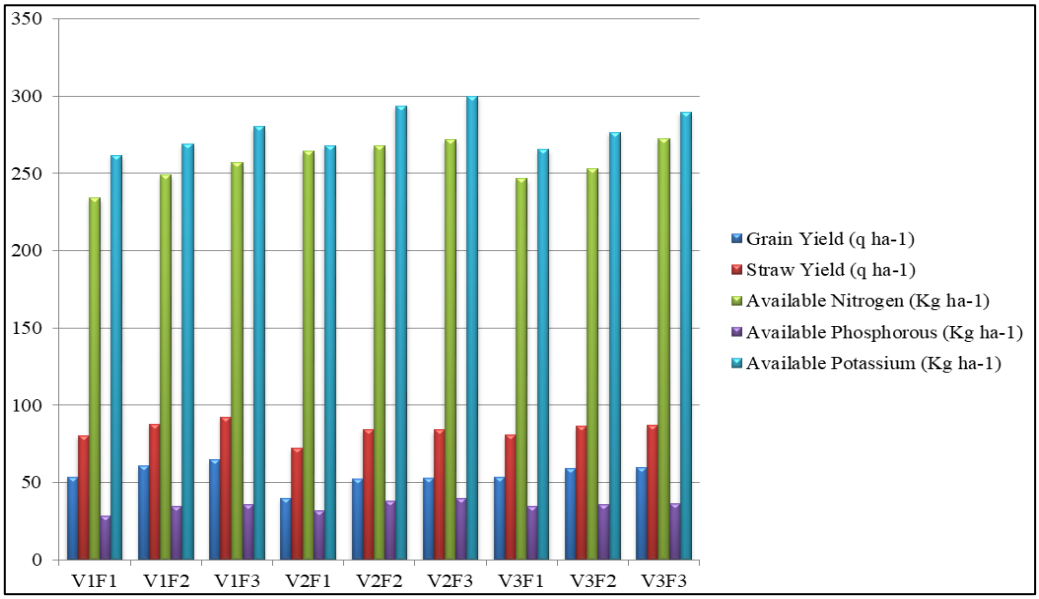


**Fig 2:** Yield of rice and available nutrient (NPK) in soil of rice crop at harvest as influenced by interactions

## II. Effect nutrient (NPK) content and nutrient (NPK) uptake of rice

### A. Effect of varieties

The nutrient (NPK) content in grain and straw of rice was significantly influenced by rice varieties. The significantly higher nutrient (NPK) content in grain and straw of rice was observed with the rice variety Indrayani which was at par with the variety Bhogawati. The lowest nutrient (NPK) content in grain and straw of rice was recorded the variety Phule Radha. Similar results were reported by Jagtap (2007) [6], Singh *et al.*, (2013) [22] and Shahane *et al.*, (2018) [20].

Among the different varieties of rice the Indryani variety recorded the higher mean total uptake of nutrients (N, $P_2O_2$, $K_2O$) and which was at par with Bhogawati and significantly superior over the variety Phule Radha. Similar findings were reported by Savant *et al.*, (2000) [18].

**Table 3:** Mean nitrogen, phosphorus and potassium content (%) of rice as influenced by different treatments

| Treatments | Nitrogen (%) | | Phosphorus (%) | | Potassium (%) | |
|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw |
| **Main plot: Rice varieties** | | | | | | |
| $V_1$- Indrayani | 1.24 | 0.78 | 0.31 | 0.19 | 0.14 | 1.49 |
| $V_2$- Phule Radha | 1.14 | 0.68 | 0.27 | 0.14 | 0.11 | 1.42 |
| $V_3$- Bhogawati | 1.22 | 0.74 | 0.28 | 0.17 | 0.13 | 1.45 |
| S. Em± | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |
| C. D. at 5% | 0.05 | 0.06 | 0.03 | 0.03 | 0.02 | 0.04 |
| **Sub plot: Fertilizer levels** | | | | | | |
| $F_1$ - 75% RDF | 1.09 | 0.67 | 0.26 | 0.13 | 0.10 | 1.42 |
| $F_2$ -100% RDF | 1.23 | 0.74 | 0.29 | 0.17 | 0.13 | 1.47 |
| $F_3$ - 125% RDF | 1.29 | 0.79 | 0.31 | 0.20 | 0.14 | 1.49 |
| S. Em± | 0.03 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 |
| C. D. at 5% | 0.08 | 0.07 | 0.04 | 0.05 | 0.03 | 0.05 |
| **Interactions: V × F** | | | | | | |
| S. Em± | 0.03 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 |
| C. D. at 5% | NS | NS | NS | NS | NS | NS |
| General mean | 1.20 | 0.73 | 0.29 | 0.17 | 0.12 | 1.46 |

**Table 3:** Mean total uptake of nutrients (Nitrogen, Phosphorus and Potassium) (kg ha$^{-1}$) of rice as influenced by different treatments

| Treatments | Nitrogen (kg ha$^{-1}$) | | | Phosphorus (kg ha$^{-1}$) | | | Potassium (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Total | Grain | Straw | Total | Grain | Straw | Total |
| **Main plot: Rice varieties** | | | | | | | | | |
| $V_1$ - Indrayani | 74.64 | 68.01 | 142.66 | 19.13 | 16.72 | 35.85 | 8.47 | 130.08 | 138.56 |
| $V_2$- Phule Radha | 55.5 | 55.30 | 110.86 | 13.34 | 11.86 | 25.21 | 5.75 | 114.86 | 120.62 |
| $V_3$- Bhogawati | 70.24 | 63.37 | 133.61 | 16.19 | 14.88 | 31.07 | 7.40 | 122.94 | 130.35 |
| S. Em± | 2.48 | 1.61 | 6.28 | 1.18 | 0.88 | 1.34 | 0.36 | 2.23 | 2.12 |
| C. D. at 5% | 8.94 | 5.78 | 18.58 | 3.48 | 3.04 | 5.34 | 1.17 | 8.51 | 8.47 |
| **Sub plot: Fertilizer levels** | | | | | | | | | |
| $F_1$ - 75% RDF | 53.56 | 52.77 | 106.34 | 12.98 | 10.32 | 20.31 | 5.01 | 109.12 | 114.69 |
| $F_2$ - 100% RDF | 70.73 | 63.70 | 134.44 | 16.85 | 15.12 | 31.97 | 6.93 | 127.08 | 134.65 |
| $F_3$ - 125% RDF | 76.14 | 70.21 | 146.35 | 18.83 | 18.02 | 36.85 | 7.80 | 131.68 | 140.19 |
| S. Em± | 1.88 | 1.95 | 6.00 | 0.76 | 1.02 | 1.47 | 0.29 | 1.47 | 1.92 |
| C. D. at 5% | 6.25 | 7.12 | 17.82 | 2.93 | 3.18 | 5.89 | 0.97 | 6.01 | 7.47 |
| **Interactions: V × F** | | | | | | | | | |
| S. Em± | 1.67 | 1.61 | 10.39 | 0.69 | 1.77 | 2.22 | 0.35 | 3.48 | 3.63 |
| C. D. at 5% | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| General mean | 66.81 | 62.23 | 129.05 | 16.22 | 14.5 | 30.71 | 7.21 | 122.63 | 129.84 |

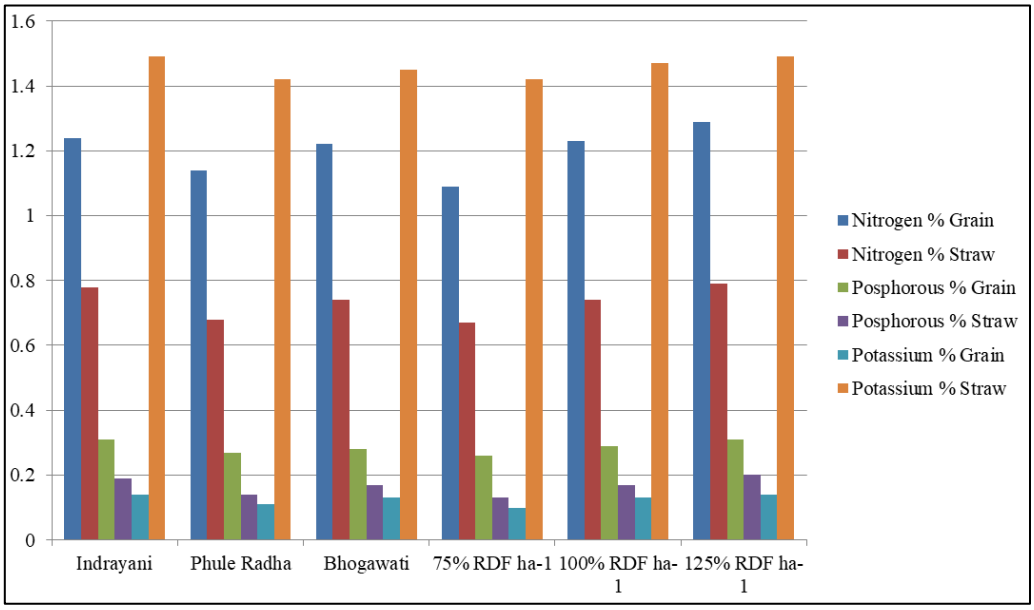


**Fig 3:** Nurtient content of rice as influenced by different treatments

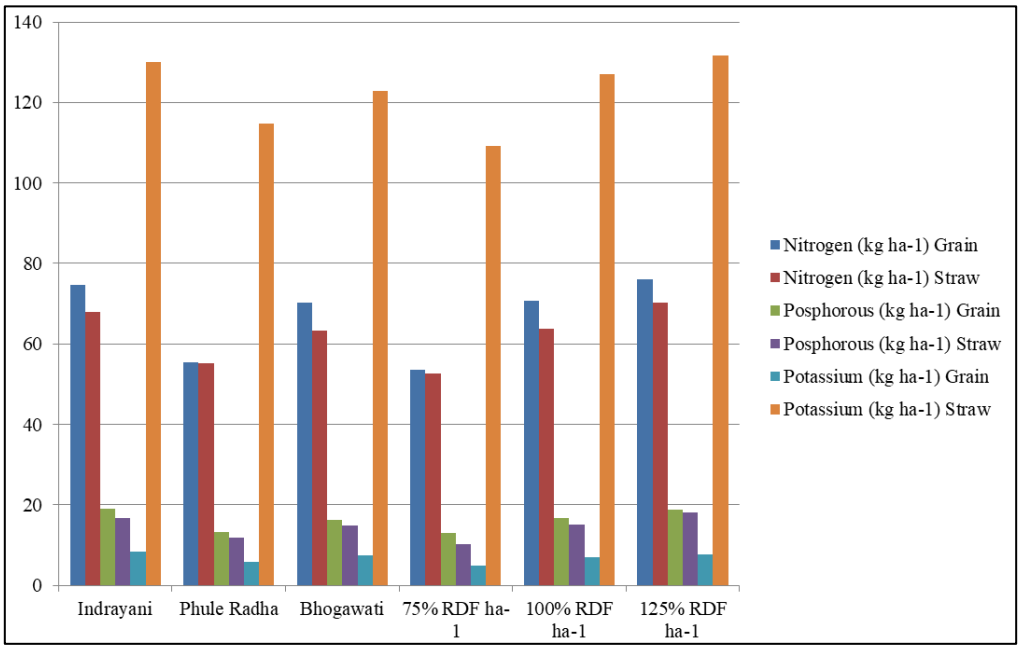


**Fig 4:** Nutrient content of rice as influenced by different treatments

**B. Effect of fertilizer levels**

The nutrient (NPK) content in grain and straw of rice was significantly influenced by fertilizer levels. The application of 125% RDF through straight fertilizers recorded significantly higher nutrient (NPK) content in grain and straw of rice over the rest of fertilizer levels and which was at par with application of 100% RDF. The lowest nutrient (NPK) content in grain and straw of rice was recorded with application of 75% RDF. Shahane *et al*., (2018) [20], Ghorpade (2015) [3], Yesuf and Balcha (2014), Singh et al., (2013) [22] and Vijayan and Sreedharan (1972) [26] found similar research finding.

The application of 125% RDF recorded the higher mean total uptake of nutrients (N, $P_2O_2$, $K_2O$) which was remained at with the application of 100% RDF and significantly superior over the application of 75% RDF (114.69 $ha^{-1}$). Ghorpade (2015) [3], Murthy *et al*., (2015) [14], Venureddy (2014) [25] and Marskole *et al*., (2017) [13] found research findings similar with present findings.

**C. Interaction effect**

The interaction effect between different varieties and fertilizer levels was found non-significant in respect of nutrient (NPK) content in grain and straw of rice and total uptake of nutrients (N, $P_2O_2$, $K_2O$) by rice crop.

**Conclusion**

Based on the agronomic investigation it can be concluded that among the varieties, Indrayani as well as Bhogawati is suitable for gaining more yield and nutrient uptake in Sub Montane Zone of Maharashtra and in Kolhapur district under dry seeded condition. Among the fertilizer levels tried, the application of 100% RDF $ha^{-1}$ and 125% RDF $ha^{-1}$ is suitable for more yield and nutrient uptake of rice under dry seeded condition. Among the interaction combinations, rice variety Indrayani applied with 125% RDF $ha^{-1}$ recorded highest yield than rest of the treatment combinations. Rice variety is highly responsive to higher doses of fertilizer levels so, 125% RDF $ha^{-1}$ can be recommended for better yields and nutrient uptake.

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