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# Effect of *panchagavya* and recommended dose of fertilizers on growth, nutrient content and productivity of transplanted rice (*Oryza sativa*) under middle Gangetic plain of India

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ABSTRACT

A field trial was conducted at the Agricultural Research Farm, Banaras Hindu University during 2013-14 and 2014-15 to study the effect of time and rate of *panchagavya* application and recommended dose of fertilizers (RDF) on growth, nutrient content and productivity of transplanted rice (*Oryza sativa* L.). Interaction of *panchagavya* and RDF exhibited significant effect on dry matter accumulation, productive tillers/$m^2$ as well as grain and straw yields of rice. Enhancement by 42% in the number of productive tillers/$m^2$ and 33% in grain yield was observed with the combination of D4 (seedling root dip + one spray at 30 DAT @ 6% + application through irrigation water at 60 DAT) + 100% RDF over 60%RDF without *panchagavya*. Application of *panchagavya* (D4) significantly increased nitrogen, phosphorus and potassium content in grain and straw following higher total uptake of these elements.120% RDF significantly increased the N, P and K content in grain and straw over 60, 80 and 100% RDF. Productive tillers/$m^2$, panicle length and filled spikelets/panicle showed linear response with yield. Residual effect of *panchagavya* (D4) in combination with 100% RDF recorded 27% increment in the yield of lentil.

**Key word:** Dry matter accumulation, *Panchagavya*, Productive tillers/$m^2$, Residual effect

*Vrikshayurveda* includes systematizations of the traditional practices followed by farmers in the field from time immemorial. It describes several growth stimulants for improving the quantity and quality of plant life and includes *panchagavya* which claims to play an important role. This miraculous combination of five 'gavya' (five products viz. milk, curd, ghee, dung and urine obtained from cow) enhances enormously the biological efficiency and quality of various crop products. Descriptions of this holy combination could be traced out in *Vedas*- the divine script of Indian wisdom. Milk contains valuable micronutrients, carotenoids, flavones, phenolic compounds, steroids, vitamins and several minerals. *Panchagavya*-considered to be a highly effective liquid organic manure with multiple functions and can effectively supplement to chemical fertilizers and pesticides (Natarajan 2008).

Rice (*Oryza sativa* L.) is generally grown under puddled condition and application of fertilizer in the puddled soil leads to the loss of N (NUE is 30-50%, PUE is 15-20%, Annon. 2014) by several means like leaching, denitrification, volatilization, run-off. The price of inputs, mainly inorganic fertilizers, is increasing day by day; therefore emphasis is needed to be given to maximize the nutrient-use efficiency and grain yield, and minimize the cost of production. The efficiency of applied nutrient can be raised by the combined use of organic liquid manure and inorganic fertilizers by supplying the nutrients at the peak period of demand. However, it is imperative to use technologies in integrated manner so that the potential yield of hybrid rice could be realized on sustained basis (Pandey *et al*. 2007). The system of rice intensification (SRI) can potentially be an approach to increase rice production at affordable costs for small-scale farmers without harming the environment (Mishra *et al*. 2007).

Optimization of nutrient supply to the crop in intensive agriculture depends on organic manures applied to the individual crop and their carry-over effect on the succeeding crop, which is generally ignored and the recommended dose of manures or fertilizers are applied to the next crop also. Complementary use of organic and biological sources of plant nutrient along with chemical fertilizer is of great importance for the maintenance of soil health and productivity. Application of FYM (50% or 100%) in *kharif* rice induces higher residual contribution of nutrients like N, P, K and S to the succeeding *rabi* lentil crop (Pankaj *et al*.

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2013). Accordingly residual effect of *panchagavya* along with different levels of recommended dose of fertilizer on lentil was the matter of study. Keeping these facts in view, the following investigation was carried out to study the influence of *panchagavya* and recommended dose of fertilizers on growth, nutrient content and productivity of transplanted rice and its residual effect on lentil under middle Gangetic plain of India.

## MATERIALS AND METHODS

The present field trial was conducted at the Agricultural Research Farm, Banaras Hindu University during two consecutive years of 2013-14 and 2014-15. The soil of the experimental site was Gangetic alluvial (typic *Ustochrepts*) in type and sandy clay loam in texture with *p*H (7.38). The soil was moderate in fertility status with low organic carbon (0.34%) and available nitrogen (206.2 kg/ha), medium available phosphorus (22.69 kg/ha) and potassium (195.52 kg/ha). The experiment was laid out in the split-plot design with four RDFs [60, 80, 100 and 120% recommended dose of fertilizer] assigned to main plots. The 100% RDF was considered as 150 kg N, 75 kg $P_2O_5$, 75 kg $K_2O$/ha and 5.25 kg Zn/ha. Each main plot was further divided into 5 sub-plots to accommodate five levels of *panchagavya* [control, three sprays of *panchagavya* at 15, 30 and 45 DAT @ 3%, seedling root dip of *panchagavya* + one spray at 30 DAT @ 3% + application through irrigation water at 60 DAT, three sprays of *panchagavya* at 15, 30 and 45 DAT @ 6 %, seedling root dip of *panchagavya* + one spray at 30 DAT @ 6% + application through irrigation water at 60 DAT]. All the 20 treatment combinations consisting of 4 main plot and 5 sub-plot treatments were replicated thrice. The hybrid rice variety PRH 10 was the test crop and sown using a seed rate of 5 kg/ha in the nursery. The field was puddled thoroughly and 14-day old seedlings were transplanted @ one seedling/hill at 25 × 25 cm spacing on first week of July and harvested in the third week of October. One fourth dose of nitrogen and full dose of $P_2O_5$, $K_2O$ and Zn were applied after last puddling and remaining three-fourth in two splits- first two-fourth at tillering stage (30 days after transplanting) and second one-fourth at panicle initiation stage (55 days after transplanting) respectively. Source of fertilizer for NPK and Zn were urea, single super phosphate, muriate of potash and zinc sulphate, respectively.

Table 1 Ingredients used for preparation of panchagavya for 50 litre

| Ingredients | Quantity |
|---|---|
| Fresh cow dung | 12.5 kg |
| Cow's urine | 7.5 l |
| Cow's Milk | 7.5 l |
| Cow's Curd | 5 l |
| Cow's ghee | 2.5 kg |
| Jaggery | 1.25 kg+12 l water |
| Banana (ripe) | 30 No. |

For preparing *panchagavya*, a wide mouthed plastic jar/can was used as metal containers are not recommended to be used. First the fresh cow dung and cow's ghee were put into container and mixed thoroughly twice daily for 3 days. On the fourth day rest of the ingredients were added and stirred twice daily for 15 days. The *panchagavya* stock solution was ready after the 20$^{th}$ day (Natarajan 2008). It was kept in the shade and covered with a plastic mosquito net to prevent houseflies from laying eggs and the formation of maggots (worms) in the solution. Whenever required suitable quantity of water was added to keep the slurry in a liquid state. Three and six per cent solutions were used for spray at 15, 30 and 45 DAT as per the treatment. The 15 and 30 litres of *panchagavya* in every 500 litres of water were applied to rice at 3 and 6% solutions respectively for 1 ha of rice. After dilution, the *panchagavya* solution was filtered and sprayed through knapsack sprayer. The solution of *panchagavya* was mixed with irrigation water @ 50 litres/ha. Roots of rice seedlings were dipped in three and six per cent solution of *panchagavya* for half a minute before transplanting. The following parameter were studied.

*Dry matter accumulation/hill:* Five hills were randomly selected from the sampling rows just before harvesting and were cut from the base. The collected samples were oven dried at 70℃ for 48 hr and weighed till the constant weight was obtained. The weight thus obtained was recorded as dry weight/hill (g) after dividing the total weight of five hills by the total number of hills (05).

*Productive tillers/m$^2$:* Number of productive tillers/m$^2$ was counted at three selected places of the sampling area in each plot, averaged and expressed in number of tillers/m$^2$.

## RESULTS AND DISCUSSION

*Dry matter accumulations*

It was clear from the Table 3 that the interaction effect between *panchagavya* and RDF on dry matter accumulation (DMA) was significant at harvest. Application of 120% RDF along with $D_4$ (seedling root dip + one spray at 30 DAT @ 6% + application through irrigation water at 60 DAT) registered the highest DMA (74.78 g/hill. As expected the lowest DMA of 54.42 g/hill was obtained at 60% RDF along with control. Obviously the plant supplied with higher NPK and Zn levels (Gautam *et al*. 2008) along with *panchagavya* produced more leaves and recorded higher plant height. Presence of growth enzymes in *panchagavya* favored rapid

Table 2 Methodologies for the determination of N, P and K content in rice plant

| Analysis | Method | Reference |
|---|---|---|
| Total 'N' | Micro Kjeldahl method | Jackson 1973 |
| Total 'P' | Vanadomolybado phosphoric acid yellow colour method | Jackson 1973 |
| Total 'K' | Flame photometer method | Jackson 1973 |

Table 3 Interaction effect of fertilizer dose and time and rate of *panchagavya* application on dry matter accumulation and productive tillers/$m^2$ of rice

| Treatment | Dry matter accumulation (g/hill) | | | | | Productive tillers/$m^2$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | Mean | F1 | F2 | F3 | F4 | Mean |
| D0 | 54.42 | 55.50 | 57.12 | 58.99 | 56.51 | 144.86 | 153.04 | 161.17 | 158.17 | 154.31 |
| D1 | 56.93 | 60.55 | 62.86 | 67.02 | 61.84 | 151.88 | 183.48 | 225.09 | 204.07 | 191.13 |
| D2 | 58.24 | 61.19 | 64.54 | 69.90 | 63.47 | 158.64 | 189.93 | 229.28 | 207.97 | 196.45 |
| D3 | 59.81 | 63.37 | 67.22 | 72.14 | 65.64 | 173.58 | 193.58 | 239.21 | 218.54 | 206.23 |
| D4 | 61.05 | 65.06 | 69.24 | 74.78 | 67.53 | 180.43 | 199.75 | 251.58 | 230.63 | 215.59 |
| Mean | 58.09 | 61.13 | 64.19 | 68.57 | | 161.88 | 183.96 | 221.26 | 203.88 | |
| | | *SEm* ± | | *CD (P=0.05)* | | | *SEm* ± | | *CD (P=0.05)* | |
| D at same level/ different F | | 0.40 | | 1.15 | | | 5.03 | | 9.80 | |
| F at same level/ different D | | 0.59 | | 1.36 | | | 3.58 | | 11.26 | |

D0-Control, D1-Three sprays at 15, 30 and 45 DAT @ 3%, D2-Seedling root dip + one spray at 30 DAT @ 3% + applicationthrough irrigation water at 60 DAT, D3-Three sprays at 15, 30 and 45 DAT @ 6%, D4-Seedling root dip + one spray at 30 DAT @ 6% + application through irrigation water at 60 DAT. F1-60, F2-80, F3-100 and F4 120% RDF, where 100% RDF means 150, 75, 75, and 5.25 kg/ha NPK and Zn, respectively. Value in tables and figures are mean of two years study.

cell division and multiplication (Sanjutha *et al*. 2008)which resulted higher dry matter production.

*Productive tillers/$m^2$*

Application of 100% RDF along with treatment D4 recorded significantly higher productive tillers/$m^2$(251.58) over rest of the treatments (Table 3). However, the minimum number of effective tillers/$m^2$ (144.86) was obtained at 60% RDF supplemented without *panchagavya,* i.e. control.

The easy transfer of nutrients to plants through foliar spray of *panchagavya* might be the reason for enhancement the number of productive tillers. Somasundaram (2003) has about the increase in productive tillers by foliar spray of *panchagavya*. Leaf area index (LAI) plays a major role in the formation of productive tillers. Since leaves are the main factors of photosynthesis and dry matter accumulation, it is expected that the treatment with optimum LAI will have more crop growth rate. But excessive leaf area index (Fig 1) increases respiration and causes reduction in crop growth rate and net assimilation rate. Therefore D4 treatment along with 100% RDF recorded optimum LAI which helps in producing the highest number of productive tillers/$m^2$ because all leaves contributed effectively in photosynthesis. On the other hand, severe reduction in net assimilation rate at the highest RDF levels (120%) was due to excessive leaf and leaf area index causing less solar radiation absorption by the leaves following shading effect by adjacent leaf and this might have reduced the number of productive tillers/$m^2$ has been reduced. Therefore, the only those tillers became productive which had optimum leaf area.

*Grain and straw yield*

Interaction effect of *panchagavya* and RDF on grain and straw yield were found significant (Table 4). Significantly higher grain yield (63.35 q/ha) was observed with the treatment combination of 100% RDF and D4 than any other combinations, while D4 levels of *panchagavya* in combination with 120% RDF recorded higher straw yield. The minimum grain and straw yield were recorded with 60% RDF without *panchagavya*.

Higher level of RDF having essential nutrients in adequate amount and balanced proportion might have increased photosynthesis and photosynthates translocation from leaf to grain leading to increased production (Sudhakar *et al*. 2006) in plot having 100% RDF + D4 level of *panchagavya*. Increasing NPKZn levels enhanced the grain yield only up to 100% RDF after which reduction in grain yield was noticed. Grain yield is considered to be the product of number of panicle bearing tillers × average number of matured grains/panicle and test weight. Continuous supply of nutrients in balanced quantity throughout the growth stages enabled the plants to assimilate sufficient photosynthetic

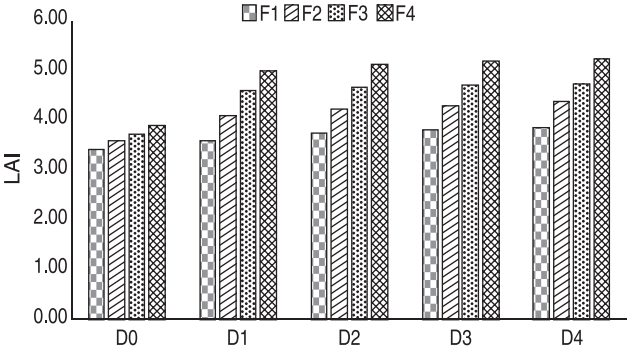


Fig 1 Interaction effect of panchagavya and RDF on LAI

Table 4 Interaction effect of fertilizer dose and time and rate of *panchagavya* application on grain and straw yield of rice

| Treatment | Grain yield (kg/ha) | | | | | Straw yield (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | Mean | F1 | F2 | F3 | F4 | Mean |
| D0 | 42.19 | 44.11 | 46.19 | 47.39 | 44.97 | 56.98 | 58.82 | 59.78 | 61.17 | 59.19 |
| D1 | 47.55 | 57.03 | 61.68 | 58.84 | 56.27 | 59.18 | 68.73 | 75.26 | 87.22 | 72.60 |
| D2 | 49.26 | 58.50 | 62.44 | 59.11 | 57.32 | 59.85 | 68.97 | 75.89 | 87.69 | 73.10 |
| D3 | 49.70 | 59.48 | 63.07 | 60.35 | 58.15 | 61.37 | 69.79 | 76.44 | 88.44 | 74.01 |
| D4 | 50.90 | 60.43 | 63.35 | 61.17 | 58.96 | 61.72 | 70.34 | 77.00 | 89.61 | 74.67 |
| Mean | 47.92 | 55.91 | 59.35 | 57.37 | | 59.82 | 67.33 | 72.87 | 82.82 | |
| | | *SEm* ± | | *CD (P=0.05)* | | | *SEm* ± | | *CD (P=0.05)* | |
| D at same level/ different F | | 1.01 | | 1.36 | | | 1.27 | | 3.52 | |
| F at same level/ different D | | 0.59 | | 1.92 | | | 1.19 | | 3.59 | |

product causing increased dry matter accumulation. With increased dry matter and efficient photosynthetic products coupled with efficient translocation, higher number of panicles with greater number of grains was produced which ultimately resulted in higher grain yield at higher level of fertility. Reduction in grain yield by application of 120% RDF along with *panchagavya* was due to less number of filled spikelets because higher vegetative growth caused less translocation of photosynthates to form grain (Adelusi and Akamo 2006). Application of optimum dose of NPKZn along with *panchagavya* increased vigour, photosynthatic accumulation and better translocation of photosynthates to the sink (Khanda and Dixit 1995).

*Panchagavya* alone in different formulations as well as in combinations with various fertility levels brought about significant and positive changes in both grain and straw yields of rice. D4 package along with 100% RDF (Table 4) produced higher grain yield but higher straw yield was registered under 120% RDF along with D4 during both the years. In almost all the vegetative and reproductive characters similar trend was observed. Organics through *panchagavya* improved the soil quality and other physico-chemical properties which helped plant take up more nutrients from soil and transform it into useful sink. *Panchagavya* - known to extend stimulatory effect to plant through phytohormones like IAA, $GA_3$, cytokinin (Xu 2001 and Somasundaram and Amanulla 2007) could successfully influence the plant to perform better which finally increased the yield by 33.40% over control where no *panchagavya* was applied.

*Nutrient content in rice*

Nitrogen content in grain and straw was significantly influenced by RDF and *panchagavya* levels (Table 5). Application of 120% RDF recorded the maximum nitrogen content in grain (1.3435%) and straw (0.6530) and was found to be significantly superior to 60 and 80% RDF. The minimum nitrogen content in grain and straw was recorded with 60% RDF. As regards the organic sources of *panchagavya*, maximum nitrogen content in grain (1.27) was observed under D4, which was significantly superior to control, D1 and D2.

Perusal of data clearly revealed that RDF and organic sources of *panchagavya* had profound effect on phosphorus content in grain and straw (Table 5). Among RDF levels, application of 120% RDF produced significantly higher phosphorus content in grain (0.2530) and straw (0.1420) significantly than 60, 80 and 100% RDF during both the years. Data further revealed that 60% RDF had minimum phosphorous content in grain and straw. Among *panchagavya* levels, D4 recorded the maximum phosphorus content in grain (0.24) and straw (0.1255) but it remained

Table 5 Effect of fertilizer dose and time and rate of *panchagavya* application on nutrient content in rice

| Treatment | Nitrogen (%) | | Phosphorus (%) | | Potassium (%) | |
|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw |
| *Fertilizer dose (4)* | | | | | | |
| F1 | 1.1510 | 0.4880 | 0.2005 | 0.0810 | 0.2405 | 1.4915 |
| F2 | 1.2035 | 0.5670 | 0.2225 | 0.0960 | 0.2655 | 1.5605 |
| F3 | 1.2665 | 0.6055 | 0.2360 | 0.1245 | 0.2845 | 1.6170 |
| F4 | 1.3435 | 0.6530 | 0.2530 | 0.1420 | 0.3130 | 1.7380 |
| SEm± | 0.0130 | 0.0080 | 0.0030 | 0.0015 | 0.0035 | 0.0165 |
| CD (*P*=0.05) | 0.0440 | 0.0270 | 0.0110 | 0.0050 | 0.0125 | 0.0570 |
| *Time and rate of panchagavya application (5)* | | | | | | |
| D0 | 1.2090 | 0.4540 | 0.1970 | 0.0790 | 0.2385 | 1.4710 |
| D1 | 1.2280 | 0.5830 | 0.2310 | 0.1125 | 0.2770 | 1.6205 |
| D2 | 1.2430 | 0.6035 | 0.2340 | 0.1165 | 0.2815 | 1.6065 |
| D3 | 1.2550 | 0.6165 | 0.2380 | 0.1220 | 0.2870 | 1.6505 |
| D4 | 1.2700 | 0.6350 | 0.2400 | 0.1255 | 0.2950 | 1.6595 |
| SEm± | 0.0035 | 0.0065 | 0.0030 | 0.0015 | 0.0020 | 0.0150 |
| CD (*P*=0.05) | 0.0110 | 0.0185 | 0.0085 | 0.0050 | 0.0060 | 0.0425 |

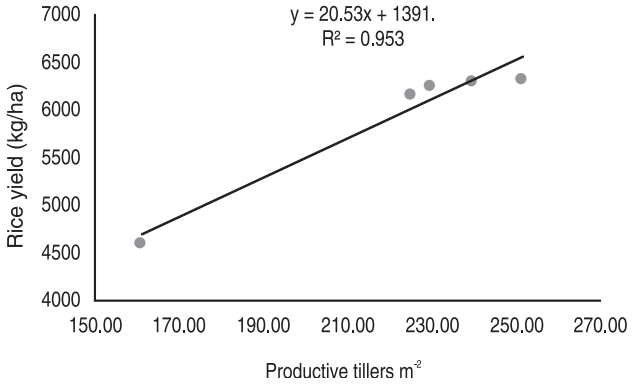


Fig 2 Relationship between rice grain yield and productive tillers/ $m^2$ based on the 100% RDF along with different levels of *panchagavya.*

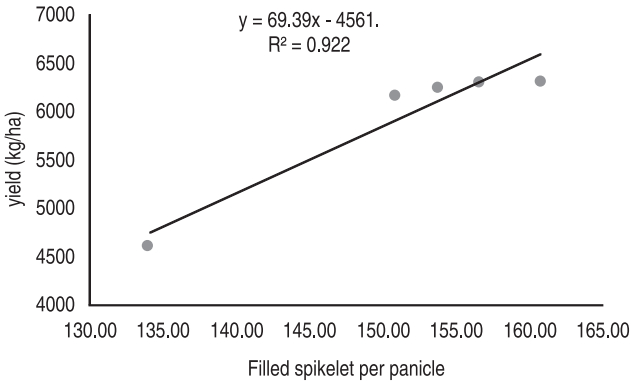


Fig 4 Relationship between rice grain yield and filled spikelet/ panicle based on the 100% RDF along with different levels of *panchagavya.*

at par with D3 (three sprays at 15, 30 and 45 DAT @ 6%).

Application of 120% RDF recorded maximum potassium content (Table 5) in grain (0.3130) and straw (1.7380) than 60%, 80% and 100% RDF. Application of 120% RDF was most effective in increasing the potassium content in grain and straw which was significantly superior to rest of the RDF during both the years. Among *panchagavya* levels, the highest potassium content in grain (0.2950) and straw (1.6595) were observed in D4 over rest of the treatments.

The NPK content of grain and straw was significantly increased with corresponding increase in NPK levels. Deficiency of either of the major elements in soil causes a physico-chemical misbalance in nutrient status rendering depressed removal of other elements. The increase in nutrient removal with the increase in fertility levels could be attributed to the better availability of nutrients, their transport to the plant from the soil and large increase in total above ground biomass (Khan *et al*. 2006).

*Residual effect on lentil*

An examination of data revealed that grain yield of succeeding lentil (Fig 5) was highly influenced by the residual effect of RDF and *panchagavya* levels. Significantly higher grain yield (1958 kg/ha) of subsequent lentil was recorded by 100% RDF in combination with D4 application. The corresponding increase in grain yield of subsequent lentil due to residual effect of 100% RDF+D4 was 30% more than 60% RDF without *panchagavya*. Significant residual effect of RDF and organic manure on succeeding crops have also been reported by several workers (Singh *et al*. 2002, Singh *et al.* 2004).

*Relationship of grain yield with productive tillers/$m^2$, panicle length and filled spikelates/panicle*

Functional relationship between rice grain yield and productive tillers/$m^2$, panicle length and filled spikelets/ panicle based on the 100% RDF along with different levels of *panchagavya* was found to be liner in nature. The effective tillers/$m^2$ ($P < 0.05$, $Y= 20.533x + 1391.3$, $R^2 = 0.9537$) in Fig 2, panicle length ($P < 0.05$, $Y= 541.17x -8936.7$, $R^2 = 0.9561$) in Fig 3 and number of filled spikelets/panicle ($Y =69.398x - 4561.6$, $R^2 = 0.9224$) in Fig 4 had a linear relationship with grain yield.

*Conclusion*

On the basis of two years of experiments the following conclusions might be drawn. The integration of 100% RDF with *panchagavya* (seedling root dip + one spray at 30 DAT @ 6% + application through irrigation water at 60 DAT)

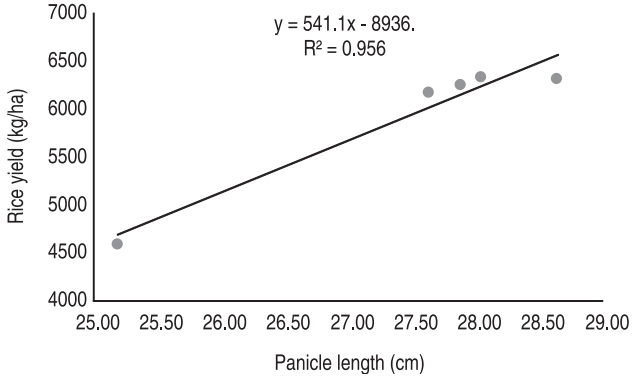


Fig 3 Relationship between rice grain yield and panicle length based on the 100% RDF along with different levels of *panchagavya.*

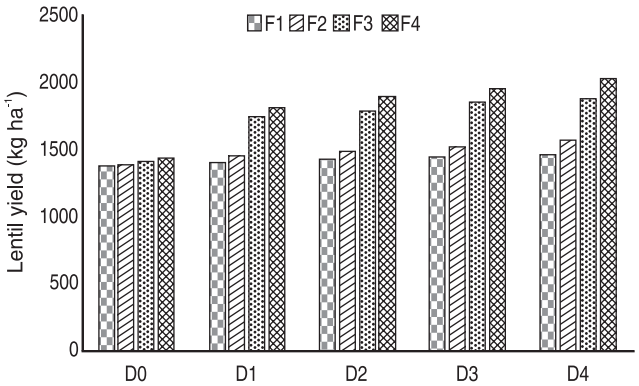


Fig 5 Residual effect of fertilizer dose × time and rate of *panchagavya application* on grain yield of lentil.

was the best combination in terms of yield. Residual effect of *panchagavya* at 100% RDF along with D4 produced 30% higher grain yield of lentil over 60% RDF without *panchagavya*. Higher nutrient content (NPK) was obtained by application of D4 level of *panchagavya*.

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