International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 914-917

Received: 16-10-2020
Accepted: 27-11-2020

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# Effect of phosphorus enriched organic manures on yield and economics of onion crop in Vertisol

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**DOI:** https://doi.org/10.22271/chemi.2021.v9.i1m.11341

**Abstract**
The experiment was conducted at Kalagi taluka in Kalaburagi district, which belongs to the Agro-Climatic Zone-2 (North Eastern Dry Zone) of Karnataka state. The experiment was laid out in split-plot design with three main plot treatments and seven sub-plot treatments. Application of P-enriched organic manures at different levels of P-fertilizers had significantly increased the bulb yield of onion. The highest bulb yield of onion (29.38 t $ha^{-1}$) was obtained with the addition of P-enriched poultry manure @ 3 t $ha^{-1}$ + 100% RDF-P which was found superior to all other treatments. The increase in yield over control (no organic manure) was 20.90% in onion crop. Addition of P-enriched poultry manure with 50 per cent RDF-P was found beneficial and yielded higher monetary returns (Rs.421454 $ha^{-1}$) and B:C ratio (6.80) from onion crop production.

**Keywords:** P-enriched organic manures, poultry manure, yield and economics

## Introduction
Onion (*Allium cepa* L.) is one of the common crop and indispensable vegetable cum condiment crop. India is the second largest onion growing country in the world. In *vertisol*, the major onion producing states are Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana, Telangana and Maharashtra ranks first in onion production (Anonymous, 2018) [1].

The phosphorus availability to crops is seldom exceeds 15-20 per cent only due to its high fixation in the soil. Hence to reduce the phosphorus fixation in soil, to enhance the efficiency of the applied phosphatic fertilizer and to keep the phosphorus more timely available to crops, the organic matter plays a greater role. Therefore, there is a need to develop viable technology to increase the efficiency of inorganic P-fertilizer through P-enriched organic manures. Enriched FYM can be used for hybrid maize production in order to get maximum grain yield and maximum farm return compared to RDF (Bekeko, 2014) [2]. So the addition of P-enriched organic manures causes higher bulb yield of onion also resulted in higher monetary returns from onion crop production. Manjunathaiah (2010) [10] revealed that the combined application of P-enriched organic manure at 100 percent RDF-P had significant effect on grain yield of maize, which accounted 27.50 per cent increase in yield over control. Sharma *et al*. (2016) [12] reported that application of 10 or 20 t $ha^{-1}$ poultry manure resulted in saving of 50 per cent of the recommended levels of both inorganic N and P fertilizers without reducing the bulb quality and yield of garlic.

## Materials and Methods
The total content of nitrogen (N), phosphorous ($P_2O_5$) and potassium ($K_2O$) in all the selected farmyard manure (FYM), vermicompost (VC), poultry manure (PM) were determined and the calculated quantity of each organic manure was taken separately and mixed well with single super phosphate. Single super phosphate mixed with organic manure were filled separately in polyethylene bag and required quantity of water was added to each bag to maintain moist condition (50% of maximum water retention capacity of the manure). These bags were kept for a period of one month by adding water as per the requirement to maintain uniform moisture level in the entire incubated time. After the incubation period of 30 days, all these manures were dried and applied to soil. Onion was grown as a test crop.

Pre-calculated quantities of N and $K_2O$ and S were given to all the plots at during transplanting of onion crop. Organic manures and P-enriched organic manures were applied in a band placement before transplanting of onion seedlings. Three levels of $P_2O_5$ that is 0, 50 and 100 per cent RDF-P was given to main plots in the form of single superphosphate to onion crop. The required quantity of fertilizers were supplied in the form of urea, single super phosphate and muriate of potash. Half the recommended dose of nitrogen, full doses of different levels of phosphatic and potassic fertilizer, were given to onion crop as a basal dose. The remaining half of the nitrogen was top dressed at 45 days after transplanting.

The soil was deep black (100-150 cm) having clay texture, soil reaction (pH) was moderately alkaline (pH) (8.1), low in salt content EC (0.19 dS $m^{-1}$), low in organic carbon content (0.39%), available N content was low (227 kg $ha^{-1}$), available $P_2O_5$ content was medium (32 kg $ha^{-1}$), available $K_2O$ content was high (418 kg $ha^{-1}$). With respect to micronutrients, DTPA extractable zinc content (0.67 ppm), iron content (7.13 ppm), Copper content (1.73 ppm) and Manganese content (15.74 ppm) were above the critical limit and nutrient composition of organic manures are presented in table 1.

**Bulb yield and Economics**

Bulb yield was calculated from the weight of bulbs harvested from the net plot of each treatment and expressed as t $ha^{-1}$. The prevailing price of inputs available at the time of their use was considered to work out the cost of cultivation. The net returns per hectare were estimated by subtracting the cost of cultivation from the gross returns. B:C ratio was worked out by using the following formula

$$\text{Benefit-cost ratio} = \frac{\text{Gross returns (₹ ha}^{-1})}{\text{Cost of cultivation (₹ ha}^{-1})}$$

**Table 1:** Nutrient composition of organic manures (on oven dry basis)

| Properties | FYM | VC | PM |
|---|---|---|---|
| pH (1:2.5) | 6.70 | 7.20 | 7.13 |
| E.C (dS $m^{-1}$) at 25 °C | 0.10 | 1.20 | 0.13 |
| **Total nutrient composition** | | | |
| Nitrogen (N)% | 0.90 | 0.70 | 3.10 |
| Phosphorus ($P_2O_5$)% | 0.60 | 0.50 | 1.20 |
| Potash ($K_2O$)% | 0.80 | 0.75 | 1.40 |

## Results and Discussion

**Bulb yield and yield attributes**

The data presented in (Table 2) showed a significant increase in bulb yield between P-enriched organic manures and organic manures. Results indicated that highest bulb yield was obtained (25.80 t $ha^{-1}$) in P-enriched PM application. Whereas, P-enriched FYM recorded 24.87 t $ha^{-1}$. Lower bulb yield (23.34 t $ha^{-1}$) was obtained in P-enriched VC. Among the organic manure tried, the lower bulb yield of 22.21 t $ha^{-1}$ and 23.52 t $ha^{-1}$ were obtained with the application of VC and FYM, respectively. Whereas, lowest in no organic treatment (21.33 t $ha^{-1}$).

Levels of P-fertilizer increased the bulb yield significantly over no P-fertilizer treatment. The maximum increase in bulb yield (26.59 t $ha^{-1}$) was observed in 100 per cent RDF-P followed by 50 per cent RDF-P (24.79 t $ha^{-1}$) and lowest in no P-fertilizer treatment (19.33 t $ha^{-1}$). The interaction of P-enriched organic manures, organic manures with P-fertilizer levels had a significant effect on onion bulb yield. The increase in onion bulb yield was maximum (29.38 t $ha^{-1}$) in the P-enriched PM at 100 per cent RDF-P.

Analysed data revealed that the bulb weight, bulb diameter and bulb yield of onion differed significantly due to addition of P-enriched organic manures and organic manures at different levels of P-fertilizer either individually or in combinations. The addition of P-enriched organic manures *viz*., PM, FYM and VC increased the bulb yield significantly to 25.80, 24.87 and 23.34 t $ha^{-1}$, respectively. This increase in bulb yield over no organic manure treatment was to the tune 20.95, 16.60 and 9.42 per cent, respectively. Whereas, among organic manures, PM recorded highest bulb yield (23.95 t $ha^{-1}$) followed by FYM (23.52 t $ha^{-1}$) and it was significant. The bulb yield was more in P-enriched organic manures compared to organic manures which can be attributed to the significant increase in the bulb weight, bulb diameter and bulb yield of onion which is due to the increase in the availability of nutrients in the P-enriched organic manures than that of organic manures. Similar finding were reported by Patel (2012) [11] revealed that the application of organic manure significantly influenced the diameter of bulb (cm), bulb weight (g) and bulb yield (t $ha^{-1}$) of onion crop. The results of present investigation are in accordance with the reports of Basavaraj and Manjunathaiah (2003) [3]. Difference among the P-enriched and organic manure treatments in bulb weight, bulb diameter and bulb yield of onion can be attributed to the difference in nutrients availability and nutrient uptake in these treatments. Sharma *et al*. (2016) [12] reported that application of 10 or 20 t $ha^{-1}$ Poultry manure resulted in saving of 50 per cent of the recommended levels of inorganic P fertilizer without reducing the bulb quality and yield of garlic.

The mean bulb weight, bulb diameter and bulb yield of onion increased significantly due to application of different levels of P-fertilizer. The bulb yield of onion in no P-fertilizer treatment was 19.33 t $ha^{-1}$ which increased progressively with increasing levels of P-fertilizer application and thus, the highest bulb yield 26.59 t $ha^{-1}$ was obtained due to application of 100 per cent RDF-P. The increase in yield over 50 and 100 per cent RDF-P was to the extent of 28.24 and 37.56 per cent, respectively. It is obvious that onion is an exhaustive crop has heavy demand for nutrients and responded significantly to increasing levels of P-fertilizer application. Similar results were reported by Dapaah *et al*. (2014) [5]. The bulb yield of onion crop in no P-fertilizer treatment was 19.33 t $ha^{-1}$, which increased to a maximum of 29.38 t $ha^{-1}$ due to addition of P-enriched PM along with the application of 100 per cent RDF-P which accounted 51.99 per cent increase in yield over control. The results are in conformity with the findings of Kuntyyastuti (2015) [9] in soybean with the different levels of phosphate fertilizer. It is interesting to note that the yield difference between 50 per cent RDF-P with and full RDF-P with organic manures was about 2.39 t $ha^{-1}$. But, in no P-fertilizer treatment yield reduction was to the tune of 7.26 t $ha^{-1}$. Hence, this suggests P requirement of the crop can be met out with 50 per cent RDF-P through inorganic fertilizer without much reduction in bulb yield. Chesti (2006) [4] reported that phosphorus levels significantly increased the grain and straw yield of green gram. Phosphorus application increased grain and straw yield of green gram up to 30 kg $P_2O_5$ $ha^{-1}$ level. However further increase in phosphorus level *viz.*, 60 kg $P_2O_5$ $ha^{-1}$ had no beneficial effect on yield of green gram.

Such an increase in bulb yield due to combined application of P enriched organic manures and P-fertilizer is attributed to the fact that the added fertilizers besides meeting the immediate nutrient requirement of the crop in the early growth stages helped in reducing P fixation and increasing microbial activity

in soil. Further, the organic compounds released during the course of decomposition of organic manures augment the efficiency of added inorganic fertilizers. Because of such mutual benefit of inorganic and organic sources of nutrients coupled with the increased microbial activity in soil, the supply of nutrients to the crop is assured throughout the crop growth period. This fact is evident from the increased uptake of nutrients by onion in the treatments receiving combined application of P-fertilizer and P-enriched organic manures. The increase in the yield of various crops due to combined application of P-enriched organic manures and Organic manures with P-fertilizer was reported by Tolessa and Friesen (2004) [13] in maize, Manjunathaiah (2010) [10] in maize and Dapaah *et al*. (2014) [5] in onion. Addition of P-enriched organic manures to soil enhance the efficiency of added inorganic fertilizers particularly phosphorus by reducing the fixation and thus increases the yield. Further, it is evident from the above results that with the application of P-enriched organic manures along with 50 per cent RDF-P, it is possible to save 50 per cent cost on both organic manure and P-fertilizer without reduction in yield. The results of present investigation are in accordance with the reports of Geleta *et al.* (2017) [6] said that application of 10 or 20 t ha$^{-1}$ poultry manure attain maximum productivity of the crop and also observed that the application of FYM have better influence on growth and yield of garlic.

**Table 2:** Effect of organic manures and P-enriched organic manures at different levels of P- fertilizer on yield parameters of onion crop at harvest

| | Bulb weight (g plant$^{-1}$) | | | | Bulb diameter (cm) | | | | Bulb yield (t ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **$M_0$** | **$M_1$** | **$M_2$** | **Mean** | **$M_0$** | **$M_1$** | **$M_2$** | **Mean** | **$M_0$** | **$M_1$** | **$M_2$** | **Mean** |
| $S_0$ | 32.49 | 44.40 | 48.08 | 41.66 | 4.09 | 4.75 | 5.12 | 4.66 | 16.80 | 23.40 | 23.79 | 21.33 |
| $S_1$ | 37.15 | 49.07 | 52.58 | 46.27 | 4.30 | 4.84 | 5.50 | 4.88 | 19.04 | 25.10 | 26.40 | 23.52 |
| $S_2$ | 36.10 | 45.62 | 49.72 | 43.81 | 4.19 | 4.79 | 5.22 | 4.73 | 17.32 | 23.58 | 25.73 | 22.21 |
| $S_3$ | 37.96 | 50.02 | 53.59 | 47.19 | 4.49 | 4.86 | 5.65 | 5.00 | 19.19 | 25.24 | 27.41 | 23.95 |
| $S_4$ | 39.12 | 49.23 | 54.72 | 47.69 | 4.53 | 4.87 | 5.76 | 5.05 | 21.44 | 25.08 | 28.09 | 24.87 |
| $S_5$ | 39.75 | 47.18 | 51.21 | 46.05 | 4.23 | 4.81 | 5.49 | 4.85 | 20.52 | 24.15 | 25.35 | 23.34 |
| $S_6$ | 41.73 | 51.76 | 57.62 | 50.37 | 4.75 | 4.91 | 5.74 | 5.14 | 21.02 | 26.99 | 29.38 | 25.80 |
| Mean | 37.76 | 48.18 | 52.50 | 46.15 | 4.37 | 4.84 | 5.50 | 4.90 | 19.33 | 24.79 | 26.59 | 23.57 |
| | S.Em± | | C D (P=0.05) | | S.Em± | | C D (P=0.05) | | S.Em± | | C D (P=0.05) | |
| Main plot | 0.115 | | 0.452 | | 0.007 | | 0.028 | | 0.085 | | 0.335 | |
| Sub plot | 0.160 | | 0.458 | | 0.018 | | 0.052 | | 0.192 | | 0.550 | |
| Interaction | 0.276 | | 0.561 | | 0.031 | | 0.063 | | 0.332 | | 0.674 | |

Main plot: P-fertilizer application (M)
M0: No P- fertilizer (RDF-NK)
M1: 50% recommended dose of P-fertilizer (30 Kg P2O5 ha-1) (RDF-NK)
M2: 100% recommended dose of P-fertilizer (75 Kg P2O5 ha-1) (RDF-NK)
RDF: 125:75:125:50; N: P2O5: K2O: S; Kg ha-1

Sub plot: Organic manures application (S)
S0: Control (No organic manure)
S1: Farmyard manure @ 12 t ha-1
S2: Vermicompost @ 6 t ha-1
S3: Poultry manure @ 6 t ha-1
S4: P- Enriched Farmyard manure @ 6 t ha-1
S5: P- Enriched Vermicompost @ 3 t ha-1
S6: P- Enriched Poultry manure @ 3 t ha-1

**Economics of P-enriched organic manures at different levels of P-fertilizer of onion crop**

The data (Table 3) revealed that the net profit in the control was Rs.229440 per hectare with a B:C ratio of 5.09. Application of P-enriched organic manures alone increased the net profit substantially. However, maximum net profit was obtained due to application of P-enriched poultry manure at 3 t ha$^{-1}$ (Rs.297659) with a B:C ratio of 5.99.

Application of fertilizer at 100 per cent RDF-P increased the net profit per hectare (Rs.388872) substantially over control (Rs.267499). However, application of 100 per cent RDF-P gave marginal increase in net profit per hectare (Rs.388872) with a B:C ratio of 7.17, when compared to over application of 50 per cent RDF-P obtained a net profit per hectare (Rs.359281) with a B:C ratio of 6.80. Similar observations were made by Kumar (2015) [8] and Sharma *et al*. (2016) [12].

The combined application of P-enriched organic manures and P-levels increased the net profit per hectare substantially, among all organic manure treatments, the lowest profit per hectare (Rs.367202) with a B:C ratio of 6.23 was obtained due to higher cost of VC addition (P-enriched vermicompost at 3 t ha$^{-1}$ at 100 per cent RDF-P). Similar findings were noticed by Basavaraj and Manjunathaiah (2003) [3]. Combined application of P-enriched vermicompost at 50 per cent RDF-P is found to be appreciable to obtained the yield equal to that of P-enriched vermicompost at 100 per cent RDF-P alone. These findings are in line with the reports of Jawadagi *et al*. (2012) and Bekeko (2014) [2] in hybrid maize, Kumar (2015) [8] and Sharma *et al*. (2016) [12] on yield of garlic.

The combined application of P-enriched organic manures increased the net profit per hectare substantially, the highest profit per hectare (Rs.437731) with a B:C ratio of 8.09 was obtained due to addition of P-enriched poultry manure at 3 t ha$^{-1}$ with 100 per cent RDF-P. Combined application of P-enriched poultry manure at 50 per cent RDF-P was found to be appreciable to obtain the yield equal to that of P-enriched poultry manure at 100 per cent RDF-P alone. Similar findings were noticed by Kumar (2015) [8], Sharma *et al.* (2016) [12] and Basavaraj and Manjunathaiah (2003) [3].

**Table 3:** Economics of organic manures and P-enriched organic manures at different levels of P-fertilizer of onion crop

| | Cost of cultivation (Rs. ha$^{-1}$) | | | Gross Returns (Rs. ha$^{-1}$) | | | Net Returns (Rs. ha$^{-1}$) | | | B:C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **$M_0$** | **$M_1$** | **$M_2$** | **$M_0$** | **$M_1$** | **$M_2$** | **$M_0$** | **$M_1$** | **$M_2$** | **$M_0$** | **$M_1$** | **$M_2$** |
| $S_0$ | 56160 | 57174 | 58208 | 285600 | 397800 | 404430 | 229440 | 340626 | 346222 | 5.09 | 6.96 | 6.95 |
| $S_1$ | 60960 | 61974 | 63008 | 323680 | 426700 | 448800 | 262720 | 364726 | 385792 | 5.31 | 6.89 | 7.12 |
| $S_2$ | 68160 | 69174 | 70208 | 294440 | 400860 | 437410 | 226280 | 331686 | 367202 | 4.32 | 5.79 | 6.23 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $S_3$ | 60360 | 61374 | 62408 | 326230 | 429080 | 465970 | 265870 | 367706 | 403562 | 5.4 | 6.99 | 7.47 |
| $S_4$ | 60022 | 61036 | 62070 | 364480 | 426360 | 477530 | 304458 | 365324 | 415460 | 6.07 | 6.99 | 7.69 |
| $S_5$ | 62769 | 63783 | 64817 | 348840 | 410550 | 430950 | 286071 | 346767 | 366133 | 5.56 | 6.44 | 6.65 |
| $S_6$ | 59681 | 60695 | 61729 | 357340 | 458830 | 499460 | 297659 | 398135 | 437731 | 5.99 | 7.56 | 8.09 |
| Mean | 61159 | 62172 | 63207 | 328659 | 421454 | 452079 | 267499 | 359281 | 388872 | 5.39 | 6.80 | 7.17 |

Main plot: P-fertilizer application (M)
M0: No P- fertilizer (RDF-NK)
M1: 50% recommended dose of P-fertilizer (30 Kg P2O5 ha-1)
M2: 100% recommended dose of P-fertilizer (75 Kg P2O5 ha-1)
RDF: 125:75:125:50; N: P2O5: K2O: S; Kg ha-1

Sub plot: Organic manures application (S)
S0: Control (No organic manure)
S1: Farmyard manure @ 12 t ha-1
S2: Vermicompost @ 6 t ha-1
S3: Poultry manure @ 6 t ha-1
S4: P- Enriched Farmyard manure @ 6 t ha-1
S5: P- Enriched Vermicompost @ 3 t ha-1
S6: P- Enriched Poultry manure @ 3 t ha-1

## Conclusion

It is evident from the above results that with the application of P-enriched organic manures along with 50 per cent RDF-P was found to be beneficial with respect to yield and profit, it is possible to save 50 per cent cost on both organic manure and P-fertilizer without reduction in yield.

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