

Research Article

Effects of different doses of organic and inorganic fertilizers on cauliflower yield and soil properties

Sabina Devkota^{1*}, Kamana Rayamajhi¹, Dil Raj Yadav² and Jiban Shrestha³

¹Nepal Agricultural Research Council, National Soil Science Research Centre Khumaltar, Lalitpur, Nepal

²Agricultural Research Station, Belachapi, Dhanusha, Nepal

³National Plant Breeding and Genetics Research Centre, Khumaltar, Lalitpur, Nepal

*Correspondence: sabina.devkota@gmail.com

*ORCID: <https://orcid.org/0000-0002-6557-4916>

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ABSTRACT

The experiment was conducted in research field of Agriculture Research Station at Belachapi, Dhanusha, Nepal from November, 2017 to February, 2018 to evaluate the effects of different doses of organic and inorganic fertilizers on Cauliflower yield parameters and soil properties. In the experiment, there were ten treatments consisting of different combinations of organic and inorganic fertilizers. The cauliflower variety 'Snow mystic' was grown with these treatments laid out in a Randomized Complete Block Design with three replications. The half dose of Organic manure (750 kg/ha) and half dose of farm yard manure (FYM) (20 t/ha) produced the highest curd yield (1019 g) and biomass (2046 g). The highest Nitrogen percent (0.10%), Organic matter percent (1.89%) and Phosphorus content (169.09 mg/kg) were obtained with the application of combined half dose of NPK (105:90:60 kg NPK/ha) and half FYM (20 t FYM/ha). The combined effect of application of Organic manures with inorganic fertilizers (NPK) was found to be better for crop growth and development as well as soil health improvement.

Keywords: Cauliflower, curd yield, inorganic and organic fertilizers

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INTRODUCTION

Cauliflower (*Brassica oleracea* var. botrytis) is among the most consumed vegetables in the world. It is a good source of protein, thiamin, riboflavin, phosphorus and potassium, and a very good source of dietary fibre, vitamin C, vitamin K, vitamin B6, folate, pantothenic acid and manganese (Bhandari & Kwak, 2015). Moreover, it has also medicinal values and therapeutic effects as it contains high concentration of glucothiocyanate, which is effective in the inhibition of carcinogenesis (McDonald, 1971). Cauliflower requires considerable amount of nutrients for growth and development (Chatterjee, 1993; Thakur *et al.*, 1991).

Soil organic matter is the organic substances in the soil which are originated from the decomposition of plant and animal residues (Dhakal, 2007). The productivity and fertility of the soil is directly related with the organic matter content in soil as it controls most of the soil physical, chemical and biological properties (Brady, 1988). The well decomposed organic manure is considered to be as good as lime to buffer soil acidity as it improves soil physical and chemical properties (Haynes & Naidu 1998; Yang *et al.* 2004). Due to the presence of very high population of bacteria, actinomycetes and fungi in Organic manure, the microbiological activity get increased that results into increased mineralization of organic nitrogen and thus nutrients become available to the plants (Shrestha, 2008).

The extensive application of chemical fertilizers may increase the yield of certain crops initially however there is no sustainability of yield in long run. The imbalanced use of chemical fertilizers decreases soil fertility in one hand and it was found to reduce grain yield of rice to 38% (Singh *et al.*, 2001). The Excessive or inappropriate use of chemical fertilizers (CFs) is a major cause of nutrient imbalance in soil, leading to high losses, particularly of N from the fertilizer, low N recovery (30%) (Krupnik *et al.*, 2004) and low N use efficiency (about 35%) (Cao *et al.*, 2013) in rice. On other side, the excessive use of organic manures alone may lead to toxic effects from reduced metabolite intermediates. (Liang *et al.*, 2003). As organic sources alone do not fulfil the nutrient requirement of crops due to slow release of their constituents nutrients (Miah, 1994), the judicious utilization of both organic and inorganic sources of nutrients is mostly recommended to get optimum yield as well and maintain soil sustainability. to evaluate the effects of different doses of organic and inorganic fertilizers on yield parameters of cauliflower and soil properties. Hence, the study was carried out to evaluate the effects of different doses of organic and inorganic fertilizers on yield parameters of cauliflower and soil properties.

MATERIALS AND METHODS

Study site

This experiment was carried out at research field of Agriculture Research Station farm at Belachapi, Dhanusa, Nepal from November, 2017 to February, 2018. The research farm is situated at the latitude 26° 52' 22.7" N and longitude 85° 56' 54.5" E as well altitude 101 masl. The soil was acidic with approximate PH (5.61±0.14) and low Organic Matter (1.34±0.07%). (Khadka *et al.*, 2016)

Experimental design and treatments

The ten treatments of different dose of organic manures where and inorganic fertilizers with three replications were laid out on Randomized Complete Block design where organic manures were developed from the food wastage materials. Cauliflower var. 'Snow mystic' was planted on November, 2017 and was harvested at to February, 2018. The cauliflower was transplanted at 60 x 60 cm spacing in field of 3 x 3 m² plot size adjusting 25 plants per plot. The recommended dose of fertilizers for cauliflower was 210:180:120 kg N, P₂O₅ and K₂O per hectare. All doses of P₂O₅ and K₂O and half dose of N were applied as basal dose and rest half dose of N was applied as topdressing during earthing up after 25 days of transplanting. FYM and organic fertilizers were also applied on the day of planting cauliflower.

Major soil and crop parameters were recorded after harvesting of the crop. The collected soil samples were analysed in the laboratory for pH, organic matter, total N, available P₂O₅ and

K₂O. Details of total quantity of nutrients applied in each treatment are given in Table 2 for rice and cauliflower respectively.

Table 1. Treatment combinations for the experiment in cauliflower.

Treatment symbols	Treatments	Treatment details
T1	Control	0
T2	NPK	210: 180: 120 kg NPK/ha
T3	FYM	40 t FYM/ha
T4	1/2 NPK + 1/2 FYM	105:90:60 kg NPK/ha + 20 t FYM/ha
T5	125% RDF	262.5 :225 :150 (NPK) kg/ha
T6	Recommended dose of Organic manure (OM)	1500 kg/ha
T7	Double dose of OM	3000 kg/ha
T8	Half dose of OM	750 kg/ha
T9	OM half + ½ NPK	750 kg/ha + (52.5 +45 +30) kg/ha NPK
T10	OM Half + half FYM	2000 kg/ha + 20 t/ha FYM

Data collection

Both crop parameters and soil parameters were recorded for the test crop. The data was recorded for plant spread (cm), curd spread (cm), curd depth (cm), plant height (cm), curd yield per plant, No. of leaves per plant, Biomass Yield (g/plant). Also, the soil parameters like PH, Organic Matter OM%, Total Nitrogen N%, Phosphorus (P mg/kg), Potassium (K mg/kg) were determined.

Data analysis

All agronomic parameters of respective crops were recorded and entered in MS-Excel. Data validation was carried out in MS-Excel. After cleaning, the data were analysed using STAR Software. The significant differences between treatments were determined using the least significant difference (LSD) test at 1% or 5% level of significance (Gomez & Gomez 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Yield Parameters

The data presented in Table 2 revealed that the yield parameters of cauliflower were significantly influenced by the different fertilizer sources except plant height.

The highest plant spread (75.33 cm) was recorded from the ½ Organic Manure and ½ FYM whereas the lowest value (40.40 cm) was observed in 125 % of NPK. Plant treated with NPK produced the highest curd spread (26cm) whereas the lowest value (15.63 cm) was observed in RDF Organic Manure. The highest curd depth (11.03 cm) and plant height (51.00 cm) were recorded in 1/2 NPK +1/2 FYM. Moreover, the lowest curd depth (6.37 cm) and plant height (31.66) was recorded from control. The highest curd yield (1019.00 g per plant) was recorded in ½ Organic Manure and ½ FYM and the lowest curd yield (270.47 g per plant) was obtained from Control. Recommended dose of Organic Manure produced the highest number of leaves (16.67) whereas the lowest value (13.40) was observed in ½ Organic Manure together with ½ NPK. In terms of Biomass yield ½ Organic Manure together with ½ FYM showed higher (2046.00 g/plant) result and control gave the lowest (560.73 g/plant) yield.

Table 2. Effect of different doses of Organic Manures on plant spread, curd spread, curd depth, plant height and curd yield, No of leaves per plant and biomass yield of cauliflower

S.N.	Treatment Details	Plant Spread (cm)	Curd Spread (cm)	Curd Depth (cm)	Plant height (cm)	Curd Yield / plant	No of leaves /plant	Biomass yield g/plant
1	Control	43.00	17.00	6.37	38.87	270.47	14.40	560.73
2	NPK	63.47	26.00	9.53	49.33	854.10	13.83	1696.87
3	FYM	52.67	19.93	9.87	44.73	571.33	15.13	1058.07
4	1/2 NPK + 1/2 FYM	64.47	24.73	11.03	51.00	862.33	15.73	1683.66
5	125% RDF	40.40	18.98	9.56	43.78	636.83	15.40	1108.83
6	Recommended dose of Organic Manure	52.73	15.63	8.93	46.93	736.68	16.67	1072.33
7	Double dose of Organic Manure	47.53	17.87	8.37	42.00	416.33	13.93	820.93
8	Half dose of Organic Manure	52.80	17.37	9.13	44.93	532.17	14.93	913.80
9	Organic Manure half + 1/2 NPK	48	19.40	9.20	47.80	488.00	13.40	1039.60
10	Organic Manure Half + half FYM	75.33	25.67	10.37	38.33	1019.0	16.67	2046.00
	Grand Mean	53.5	19.65	9.23	44.8	639	15.01	1200
	P value	0.0000	0.0007	0.000	0.2833	0.0000	0.0222	0.0000
	CV %	11.5	13.42	6.46	14.0	13.18	7.56	9.35
	SEM	3.073	1.569	0.344	3.62	48.6	0.657	64.8
	LSD (0.05)	10.55	4.663	1.023	10.76	144.4	1.951	192.5

CV= coefficient of variation, SEM= Standard Error of Mean, SE= Standard Error, LSD= Least Significant Difference. RDF= Recommended Dose of Fertilizer, NPK = Nitrogen, Phosphorus, Potassium. FYM= Farm Yard Manure

Soil parameters

All the soil parameters were significantly influenced by the application of Organic Manure except TN and OM. The detail of overall response is presented in the Table 3.

All the soil parameters were significantly influenced by the application of Organic Manures except TN and OM. The highest pH (5.72) was obtained from the half Organic Manures and lowest (5.06) was recorded in NPK. The maximum N (0.10 %) and OM (1.89 %) was recorded from 1/2 NPK and 1/2 FYM and lowest N (0.06 %) and lowest OM (0.92 %) were recorded in Control. In terms of K, the highest K (276.38 mg/kg) was recorded in FYM and lowest (21.11 mg/kg) was found in RDF Organic Manure. The highest P (169.09 mg/kg) was recorded in 1/2 NPK and 1/2 FYM whereas the lowest (77.45 mg/kg) was obtained from FYM.

Table 3. Effect of Organic Manure on the soil pH, organic matter, nitrogen, phosphorous, potassium content after harvest of Cauliflower

S.N.	Treatment Details	PH	TN %	OM %	Pmg/kg	Kmg/kg
1.	Control	5.60	0.06	0.92	93.09	49.25
2.	NPK	5.06	0.07	1.32	143.92	101.51
3.	FYM	5.86	0.09	1.74	77.45	276.38
4.	1/2 NPK + 1/2 FYM	5.58	0.10	1.89	169.09	169.85
5.	125% RDF	4.99	0.07	1.15	146.38	105.35
6.	Recommended dose of Organic Manure	5.62	0.08	1.37	91.96	21.11
7.	Double dose of Organic Manure	5.60	0.07	1.09	68.94	35.18
8.	Half dose of Organic Manure	5.72	0.08	1.42	90.76	41.21
9.	Organic Manure half + ½ NPK	5.24	0.08	1.39	98.01	45.23
10.	Organic Manure Half + half FYM	6.01	0.08	1.61	84.84	246.23
	Grand Mean	5.528	0.079	1.39	106.4	109
	P value	0.0294	0.2034	0.1333	0.0260	0.0161
	CV %	6.19	13.9	27.42	32.32	80.97
	SEM	0.1974	0.0063	0.2198	19.86	51.0
	LSD (0.05)	0.5866	0.0189	0.6532	59.02	151.6

CV= coefficient of variation, SEM= Standard Error of Mean, SE= Standard Error, LSD= Least Significant Difference. RDF= Recommended Dose of Fertilizer, NPK = Nitrogen, Phosphorus, Potassium. FYM= Farm Yard Manure, TN%= Total Nitrogen %, OM = Organic Matter, P = Phosphorus content, K= Potassium content

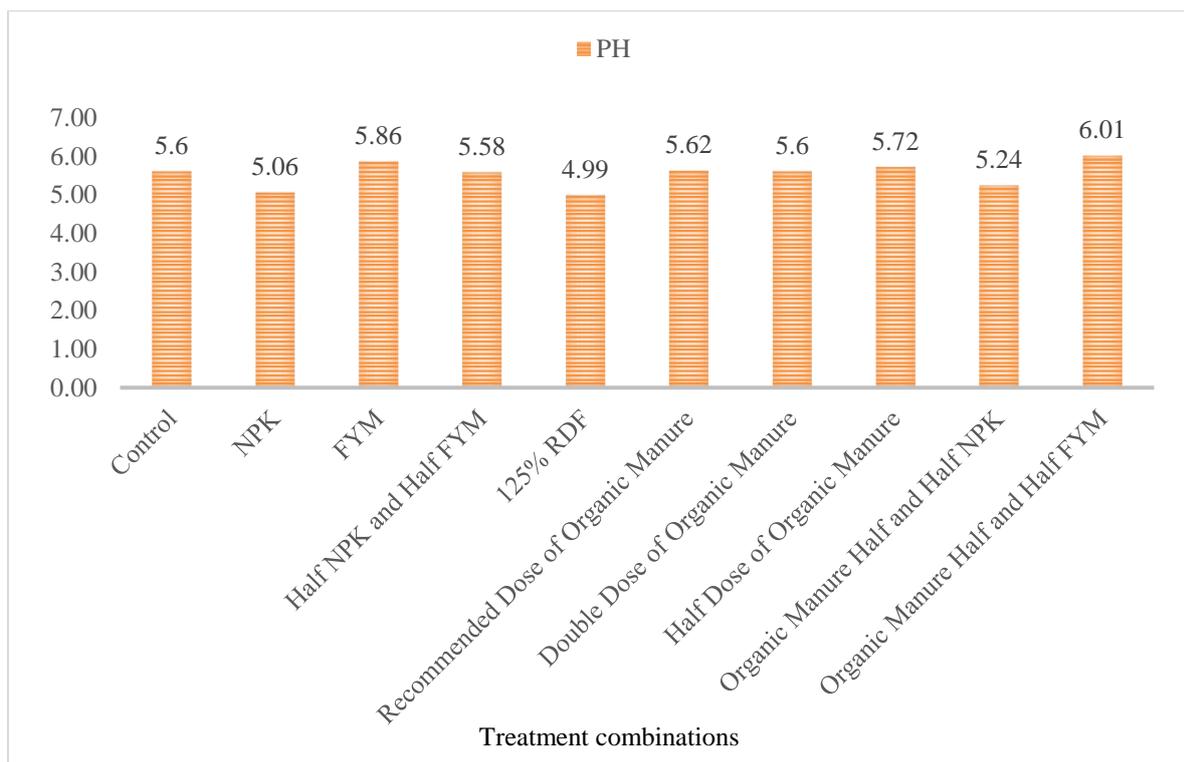


Figure 1. Diagram showing range of PH values due to application of different doses of Organic manure in the soil.

The range of PH values shown by the effect of different doses of organic manures depicts the half amount of both Organic Manures and FYM decreases the hydrogen ion concentration in the soil i.e. results into basic soil. We can see this PH value is followed by the application of FYM alone (Figure1) and then by Half dose of Organic Manures. The lowest PH value given

by 125% RDF (4.49) gave us the idea about the increasing concentration of hydrogen ions with increasing the amount of Inorganic fertilizers in the soil.

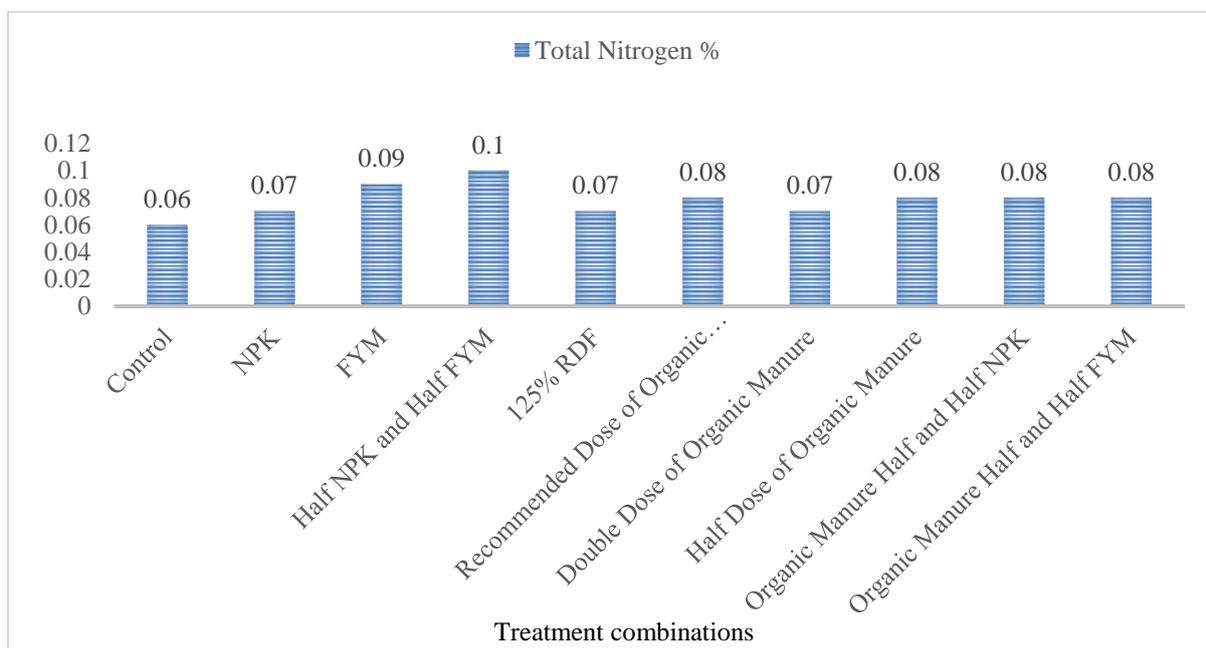


Figure 2. Diagram showing the share of the total Nitrogen content percentage in soil due to the application of different dose of Organic Manure.

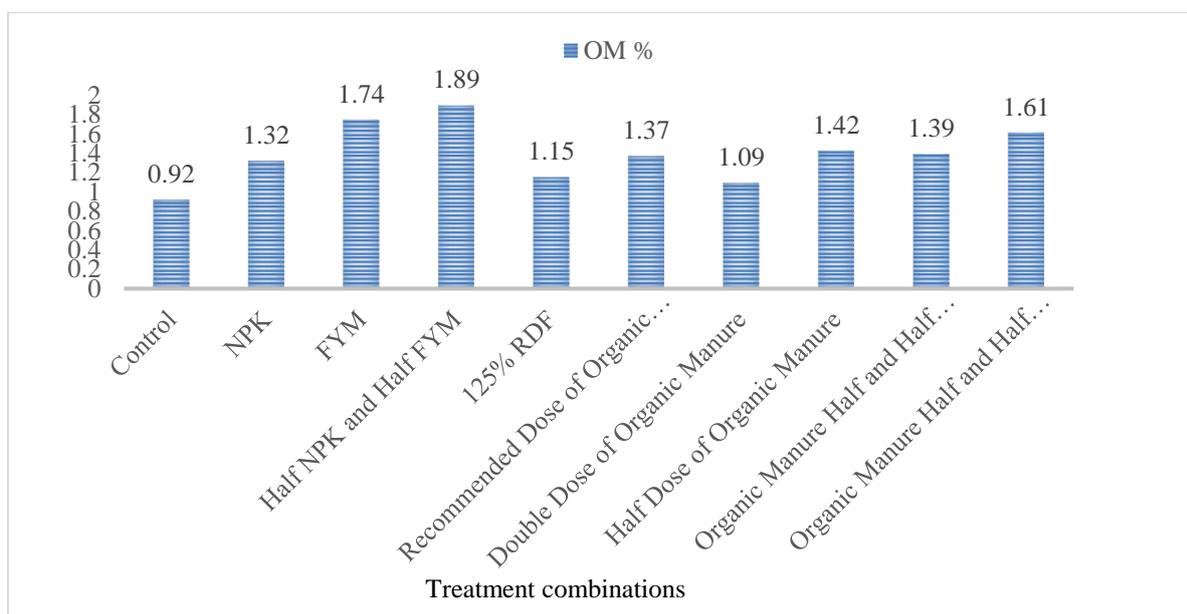


Figure 3. Diagram showing share of Organic matter percentage in soil due to application of different doses of Organic Manures.

In the total nitrogen content in the soil, the maximum amount (0.1%) is contributed by the application of Half NPK and Half FYM. This is followed by the application of FYM. (Figure 2) and there is equal amount (0.08%) of TN by the application of Recommended Dose of Organic Manure, Half Dose of Organic Manure, Organic Manure Half with Half NPK and Organic Manure Half with Half FYM. The equal amount (0.07%) obtained from the

recommended NPK and 125% more NPK shows there is no increment in total nitrogen content just by increasing the amount of inorganic fertilizers.

In the total amount of Organic Matter % in the soil, the maximum amount (1.89%) is contributed by the application of Half NPK and Half FYM. This was followed by FYM (1.74%) and Organic Manure Half with Half FYM (1.61%). However, the 125 % RDF (1.15%) and the Double Dose of Organic Manure had resulted in low amount (1.09%) of Organic Matter in the tested soil.

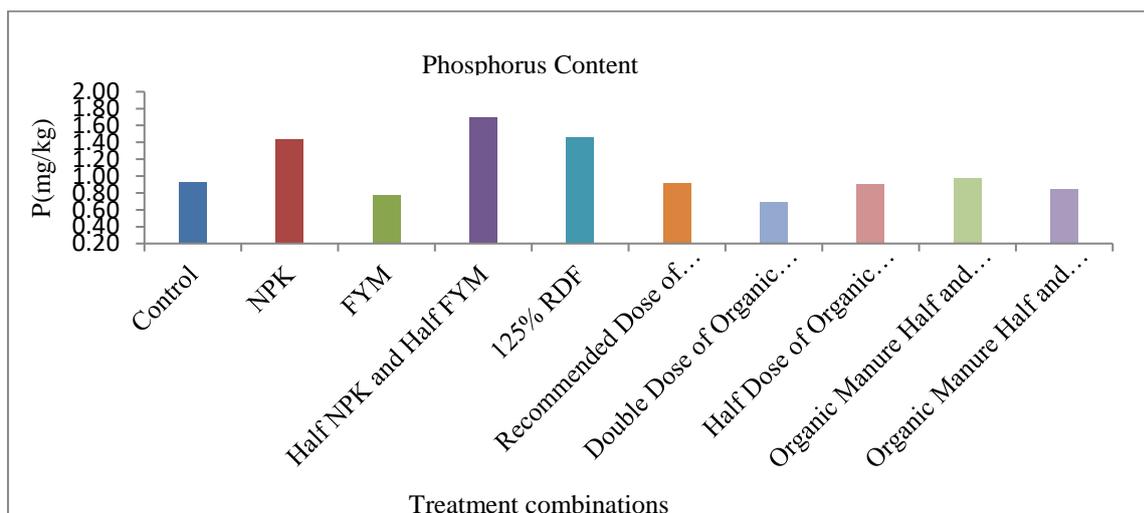


Figure 4. Diagram showing the phosphorus content in the soil due to application of different dose of Organic Manures.

The maximum phosphorus content was given by the Half NPK and Half FYM followed by 125% RDF and NPK. (Figure 4). The different doses Organic Manures viz. Recommended, Double, Half, had similar phosphorus content as in control condition. However, the Half Dose of Organic Manure and Half NPK had higher P content than that of Organic Manure Half and Half FYM. This showed that in order to increase P content, inorganic source of fertilizer needs to be increased.

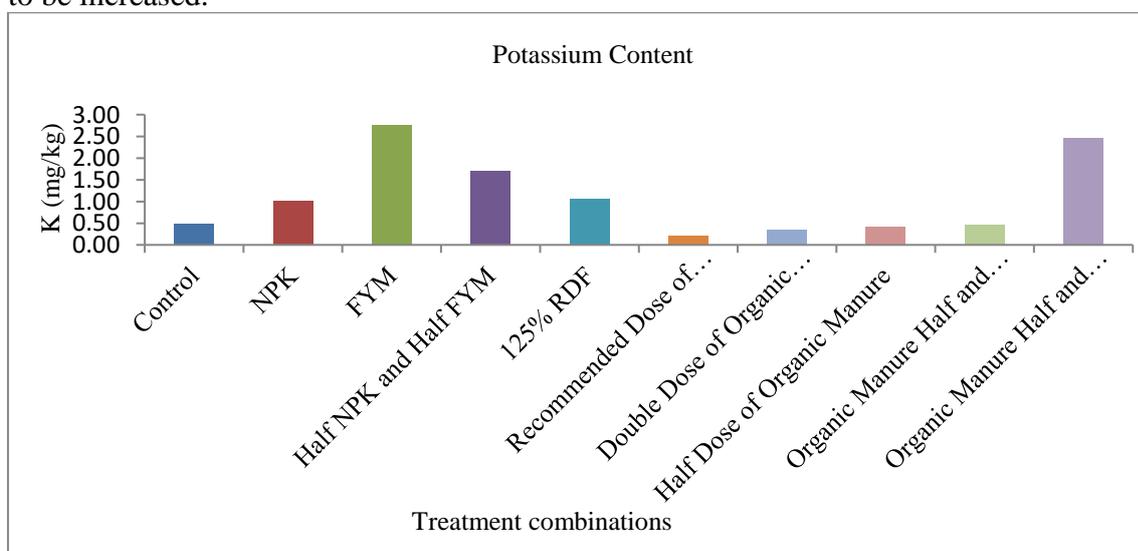


Figure 5. Diagram showing the potassium content in the soil due to application of different doses of Organic Manures.

The highest potassium content was given by FYM followed by Organic Manure Half and Half FYM. The application of Half NPK and Half FYM dose is followed by NPK and 125% RDF. However, the different doses of Organic Manures viz. Recommended, Double, Half resulted in lower amount of Phosphorus content than Half Organic Matter with Half NPK as well as control condition.

DISCUSSION

From this study, the maximum plant spread 75.33 cm was found through the application half organic manure and half NPK. The reason behind this was found to be the integrated supply of both organic and inorganic manures that results in balanced C:N ratio and abundant supply of nutrients from the soil which are translocated to the aerial parts for the synthesis of protoplasmic proteins and other metabolites enabling the expansion of photosynthetic area and thus spread. Similar findings were found in cauliflower (George *et al.*, 2004).

The curd parameters, curd spread and curd depth both were significantly influenced by the integrated application of both organic and inorganic source of fertilizers. The maximum curd spread 26 cm was found in NPK and that in curd depth 11.3 cm was found in half NPK and half FYM application. Similar results were found in plant height i.e. the maximum plant height 51 cm was found in half NPK and half FYM dose. However, the maximum number of leaves 16.67 was found in recommended dose of Organic Manure as well as half dose of Organic Manure and half NPK. This depicts that the high amount of organic manure causes increases in the number of leaves which is directly correlated to photosynthetic activity resulting to increase curd parameters. This evidence was also support by finding, the increase in the number of leaves would have enabled accumulation of more carbohydrates resulting in the increase in curd diameter. (Subhan *et al.*, 1988; Silva *et al.*, 1986)

The yield parameters (curd and biomass) yield per plant were both found to be significantly varied by the application of different doses of organic manures. The curd yield per plant (1019 g/ plant) and biomass yield (2046 g/plant) were maximum at half dose of Organic Manure and half dose of FYM. Such improvement in yield parameter may due to better availability of nutrients through judicious supply of both organic manures with FYM. Similar results were found in poultry manure fertilization as well which added supply of nutrients and proliferous root system enabling better absorption of water as well as nutrients. (Singh *et al.*, 1970). The PH value, Total Nitrogen, Organic Matter and Phosphorus content showed no significant variation among the different doses of Organic Manures may be due to buffering capacity of Organic Manures that resist change in PH values. Similar results were found by (Stevenson *et al.*, 1982). The total nitrogen %, Organic Matter%, Phosphorus and Potassium content were found maximum at half NPK and half FYM. The vegetative parameters (curd spread, curd depth and plant height) were also the maximum at half NPK and half FYM dose indicating availability of profound amount of nutrients from both organic and inorganic sources. However, the double dose of organic manure resulted in lowest amounts of Organic Matter, Total Nitrogen, Phosphorus and Potassium content. The availability of nutrients is highest with half organic and half inorganic supply than whole organic one due to the reason that the degradation of organic manure depends upon the C:N ratio i.e. FYM has approx. 16:1 (C:N), which stands above the ideal 10:1. Thus, the rate could be increased by the addition of nitrogenous fertilizers for reducing C:N ratio. (Stevenson *et al.*, 1982; Shrivastav *et al.*, 1985).

CONCLUSION

In this experiment, the different doses of Organic manures with Inorganic manures showed variable results. Neither the organic manure alone, nor the inorganic one gave the beneficial output to the crop. However, the total yield (curd and biomass) was maximum at half dose of organic manure and half FYM indicating massive availability and utilization of nutrients through Organic source. The increment in total nitrogen %, Organic matter % and Phosphorous content in the soil by half NPK and half FYM depicted the efficiency of nutrients availability through judicious management of both organic and inorganic sources of fertilizers. Since, the application of different doses of organic manure alone was not found beneficial for neither yield parameters nor the soil properties, we can conclude that the organic manure without any source of inorganic nutrients is not beneficial for overall crop growth and soil health. Hence, for the efficient utilization of organic sources of fertilizers, optimum doses of inorganic nutrients is required for soil health improvement in a sustainable way.

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Authors' Contributions

S. Devkota prepared the research concept and design, analysis and interpretation of data, drafting of the manuscript. K. Rayamajhi and D.R.Yadav contributed for acquisition and entry of data of experiment. J. Shrestha helped in data analysis and made critical revision of the manuscript.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding publication of this manuscript.

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