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Long-Term Residual Effect of Fertilizer and Manure on Yield and Nutrient Content in Greengram

V. B. KULIGOD, M. B. DODDAMANI AND S. N. UPPERI

Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences Dharwad 580005, India
E-mail : vbkuligod@yahoo.co.in

Abstract

Long term experiment conducted to study the effect of residual fertilizer and farm yard manure (FYM) in green gram indicated significant increase in yield and accumulation of nutrients. Grain yield remained higher in greengram with the residual effect of 10 t/ha FYM along with 50% recommended dose of fertilizer (RDF) (50:38:20 N, P_2O_5 and K_2O kg/ha) and 100% RDF (100:75:40 N, P_2O_5 and K_2O kg/ha) compared to 5 t/ha FYM applied to the previous crop (sorghum). Grain size and weight (1,000 grain weight) remained higher for residual effect of higher RDF (100%) along with FYM (10 t/ha). Therefore, fertilizer along with manure was essential to increase shoot and root weight of *kharif* greengram Chlorophyll, P, K, Ca, Fe and Mn contents in whole plant were not influenced by the residual effect of manure and fertilizer. However, Zn content was significantly affected. Wherever FYM was applied along with fertilizers to the previous crop (sorghum), *kharif* greengram recorded significantly higher content of Zn. The soil being highly calcareous (18% $CaCO_3$ and pH buffered at 8.5), zinc was the most deficient and yield limiting and integrated application of manure and fertilizer was most essential to meet micro-nutrient requirement of the crop. Soil status of available N, P_2O_5 and K_2O increased after harvest of greengram in the treatments that were supplied with FYM at 10 t/ha along with fertilizers to previous *rabi* crop. Available P_2O_5 was only 4 and 17 kg/ha for control and long-term 5 t/ha FYM application, respectively. These values changed to 54 kg/ha with the practice of 10 t/ha FYM along with 100% RDF application. Similarly, available N increased by one and half times due to continuous application FYM and fertilizers at the rate of 10 t/ha along with 100% RDF.

Key words : Fertilizers, Greengram, Manures, Nutrient content, Residual effect.

Synchronized application of manured and commercial fertilizers may help to obtain economically optimum crop yields and to sustain them. Land productivity remained either constant or decreased despite introduction of irrigation and high yielding hybrids in the recent past. Balakrishnan et al. (1) estimated that the farmers of Upper Krishna irrigation Project (UKP) canal commands realized 60, 52, 46, 41 and 38% lower yields compared to potential yields in cotton, sorghum, sunflower, maize and pear millet, respectively. Deteriorating soils in physical and chemical properties and fertility were the main cause along with widespread pest incidence. Swarup and Wanjari (2) through three decades of long-term research recommended that manures and fertilizers be used in conjunction to sustain higher crop yields. Addition of organic manure seems to be a key factor in improving overall productivity. Improvement in soil physical conditions through reduced bulk density, increased mean weight diameter of water stable aggregates, higher steady state infiltration rate and build-up of organic matter under integrated application of fertilizers and manures has been reported (3). Enhanced nutrient availability under long-term practice of manure and fertilizer application played an important role in increasing maize, wheat and cowpea yields (4). Dhaliwal et al. (5) and Sharma and Rajindar Kaur (6) stressed the need for integrated manure and fertilizer application in achieving stable and higher maize-wheat and rice-wheat yields, respectively. Manure application may ensure availability of nutrients to the succeeding crops. This reduces cost of cultivation, and sustains crop yields. Present investigation was conducted to assess residual influence of fertilizers and manures in combination and alone.

Methods

A long-term experiment for more than 16 years

Table 1. Long-term residual effect of manure and fertilizers on grain yield of greengram (q/ha).

Treatments	Years 2001	2002	2003	2004	2005	2006	2007	2008
1 Control	3.0	3.5	4.7	4.5	2.6	1.9	3.5	3.3
2 5 t/ha FYM	5.5	6.3	6.9	8.1	2.7	2.5	5.7	5.5
3 10 t/ha FYM	7.6	8.1	6.7	8.4	2.5	2.3	6.3	5.7
4 50% RDF	5.2	6.5	5.4	8.6	2.9	2.5	5.0	5.6
5 100% RDF	6.6	7.4	6.3	9.1	3.6	3.7	6.5	6.5
6 5 t/ha FYM + 50% RDF	7.4	9.9	6.3	9.6	4.9	4.5	7.6	7.5
7 5 t/ha FYM + 100% RDF	7.6	10.6	6.6	9.0	4.5	4.1	6.6	6.6
8 10 t/ha FYM + 50% RDF	8.4	11.8	7.5	9.3	6.9	5.6	8.3	8.3
9 10 t/ha FYM + 100% RDF	8.3	11.3	6.8	8.8	6.4	5.7	7.7	8.4
10 100% rec. N & P only	6.4	8.3	7.3	9.8	4.3	2.8	6.8	7.1
SE ±	0.8	1.0	1.0	0.7	0.9	1.0	0.7	0.8
CD (0.05)	2.3	2.2	2.1	2.0	2.1	2.2	2.0	2.4
CV (%)	13	15	15	12	11	10	13	15

was conducted at Agricultural Research Station, Bheemarayanagudi in Upper Krishna Project (UKP) Command area (latitude 16^0 44′ N and longitude 76^0 47′ E). The treatments consisted of different levels and combination of manure and fertilizer application to *rabi* season (winter) crop. Details of the treatments are as follows : T_1-control (without manure and fertilizers), T_2-5 tones farm yard manure (FYM)/ha, T_3-10 tones farm yard manure (FYM)/ha, T_4-50% RDF (recommended dose of fertilizer i.e., 50 : 37.5 : 20 kg/ha N, P_2O_5 and K_2O), T_5-100% RDF (100 : 75 : 40 kg/ha N, P_2O_5 and K_2O), T_6-5 t/ha FYM + 50% RDF, T_7-5 t/ha FYM + 100% RDF, T_8-10 t/ha FYM + 50% RDF, T_9-10 t/ha FYM + 100% RDF and T_{10}-100% recommended N and P only. The *rabi* crop was M-35-1 cultivar of sorghum (*Sorghum bicolour* L.). *Rabi* crop was followed by a pulse. During first 5 years no *kharif* crop was grown, next 5 years soybean was grown and during last 8 years greengram was grown on residual nutrients available in the soil. The plots location and treatments imposition remained same throughout the study period. Looking into the enormous data obtained during the study, influence of manure and fertilizer levels either alone or in conjunction on sorghum and soybean is not discussed here. However, the residual effect of manure and fertilizers on greengram is discussed.

Grain yield was recorded on net plot and expressed as tones per hectare. Observations on 1,000 grain weight, shoot and root weight, chlorophyll content, tissue content of P, K, Ca, Fe, Mn and Zn were also assessed by adopting appropriate methods. Surface (0—20 cm) soil samples were collected after harvest of the crop and the samples were analyzed for available N, P_2O_5 and K_2O by adopting standard analytical procedures.

Experimental soil was deep (120 cm) black and classified as *Calciusterts* under the USDA taxonomical classification. Parent material is granite gneiss and soil belonged to *Tumkur* series. The soil was calcareous with free $CaCO_3$ content ranging between 15—18%. Experimental soil was deficient in available N (160 kg/ha) and P_2O_5 (18 kg/ha) and had sufficient K_2O (450 kg/ha). Available Zn, Fe, Mn and Cu contents were 0.4, 6.1, 5.6, 0.4 mg/kg. Clay content was 62% with predominance of montmorillonite. Climate is semi-arid tropical characterized by mild winter, short monsoon and hot summer. Annual average rainfall was 573.1 mm of which 467.3 mm (82%) occurs between June and October. Average number of rainy days in a year were 29 and that corresponding to June—October were 23. Mean daily evaporation was 6.1 mm. Monthly evaporation varied from 180 to 301 mm and was maximum during April—May.

Results and Discussion

Yield Trends and Biomass Production

Grain yield of greengram differed significantly among various treatments that comprised of graded levels of manure and fertilizer application in conjunction or alone (Table 1). During all the experimentation years, application of ten tones/ha FYM along with either 50% RDF or 100% RDF recorded maximum yield.

Table 2. Long-term residual effect of manure and fertilizers on 1,000 grain weight, shoot and root weight, chlorophyll and nutrient content.

	Parameters									
Treatments	1000 grain weight, g	Shoot weight/ plant	Root weight plant	Chlorophy-II content	P, %	K, %	Ca, %	Fe, ppm	Mn, ppm	Zn, ppm
1 Control	24.8	0.513	0.050	2.137	0.24	1.91	2.54	735	192	54
2 5 t/ha FYM	26.0	0.866	0.086	2.057	0.29	2.30	2.47	669	192	92
3 10 t/ha FYM	27.9	1.203	0.113	1.950	0.34	2.47	2.66	646	186	227
4 50% RDF	26.6	0.770	0.080	1.950	0.25	2.26	2.77	497	146	85
5 100% RDF	27.7	1.036	0.090	1.850	0.33	1.97	2.83	584	147	114
6 5 t/ha FYM + 50% RDF	27.1	1.367	0.113	2.040	0.34	1.92	2.99	545	159	270
7 5 t/ha FYM + 100% RDF	28.6	1.540	0.156	2.020	0.36	2.11	2.79	738	176	219
8 10 t/ha FYM + 50% RDF	28.1	1.410	0.140	1.990	0.28	2.04	2.69	838	166	271
9 10 t/ha FYM + 100% RDF	28.4	1.616	0.150	2.006	0.38	1.88	2.82	681	146	202
10 100% rec. N & P only	26.1	1.337	0.100	2.056	0.32	1.91	2.7	574	150	72
SE ±	1.0	0.262	0.012	0.095	0.02	0.30	0.22	113	26	59
CD (0.05)	2.1	0.552	0.054	NS	NS	NS	NS	NS	NS	123
CV (%)	5	8	9	6	2	8	10	21	19	25

This indicated that manure application at 10 tones/ha along with RDF had maintained higher and residual nutrient content of the soil. Therefore, integrated application of manure and fertilizer was beneficial not only to first crop even to the subsequent legume crop. Application of manure alone at 10 t/ha found to be better compared to 100% fertilizer application as former treatment registered higher yields during four out of eight years. Therefore, manure by its slow nutrient releasing mechanism could have residual effect on succeeding legume crop through higher nutrient supply. Average grain yield of greengram remained highest with 10 t/ha FYM along with 50% RDF. Pal et al. (7) has also reported that adequate availability of nutrient under integrated nutrient management resulted in higher grain yields of rice and horse gram in a long-term experiment. The results of the present investigation fall in line with those of Swarup and Wanjari (2). Mondal et al. (8) reported that application of single super phosphate at higher doses to the preceding crop had increased succeeding greengram grain yield. Thousand grain weight remained unaffected whether manures and fertilizers are applied separately or in conjunction (Table 2). Grain size was least in the plots that did not receive manure and fertilizers for long time.

Available Nutrients

Nitrogen. Average available N after harvest of greengram remained highest (225 kg/ha) for 10 t/ha manure along with 100% RDF application followed by 10 t/ha FYM along with 50% RDF (Table 3). Comparison between 10 t/ha (204 kg/ha) and 5 t/ha (184) FYM application without fertilizer makes it clear that FYM at higher dose had long-term residual effect and sustained release of nitrogen. Residual available nitrogen content was significantly lower in the plots that received 100% RDF (186 kg/ha) compared to 10 t/ha FYM (204 kg/ha). Pal et al. (7) demonstrated prolonged release and maintenance of higher nutrient concentration in soil solution through their experiment. Available nitrogen decreased drastically in control plots where neither fertilizer nor manures were applied.

Phosphorus. Experimental soil was low in available P_2O_5 content and it decreased further in control plots due to mining by crop plants (sorghum in *rabi* and greengram in *kharif*). Due to build-up of available phosphorus by added manure and fertilizers, available P_2O_5 was rated as sufficient in 10 t/ha FYM along with 100 per cent RDF applied plots (Table 3). Available P_2O_5 remained higher in the plots where integrated nutrient management was practiced by application of both fertilizer and manure. Application of fertilizers alone were noted to be better in comparison to manures alone in maintaining higher available phosphorus. Sihag et al. (9) also made similar obser-

Table 3. Long-term residual effect of manure and fertilizers on soil available nutrients.

Treatments	Soil available nutrients (kg/ha^{-1}) N	P_2O_5	K_2O
1 Control	151	4.1	565
2 5 t/ha FYM	184	17.3	610
3 10 t/ha FYM	204	25.7	765
4 50% RDF	176	22.3	690
5 100% RDF	186	30.5	745
6 5 t/ha FYM + 50% RDF	190	37.6	680
7 5 t/ha FYM + 100% RDF	197	42.7	680
8 10 t/ha FYM + 50% RDF	206	47.8	725
9 10 t/ha FYM + 100% RDF	225	54.2	725
10 100% rec. N & P only	183	32.6	620
SE ±	8	2.0	35
CD (0.05)	16	4.2	73
CV (%)	5	8	6

vation of higher P accumulation due to farm yard manure incorporation. Sharma and Manohar (10) noticed build-up of available phosphorus and sulfur in soils after harvest of succeeding crop due to application of fertilizers to previous crop. Therefore, residual build-up of phosphorus occurs due to increased doses of fertilizer application.

potassium. Soil being sufficient in available potassium, significant decrease to less than critical value was not observed despite application of potassium was with-held for long period in control plots and also in 100 per cent N and P application (Table 3). Available potassium remained highest for soil application of either 100 or 50% RDF along with 10 t/ha FYM. Thus, higher available K status could be achieved only through combined application of manure and fertilizer.

Tissue Nutrient and Chlorophyll Content

Chlorophyll, P, K, Ca, Fe and Mn content of the plant tissue remained unchanged due to graded level of manure and fertilizer application (Table 2). However, Zn content in the plant tissue varied widely among the different treatments. Application of organic manure and its higher dose induced uptake and accumulation of zinc. Combined application of RDF and manures had facilitated the crop to absorb more and more Zn. Increased uptake of Zn under the influence

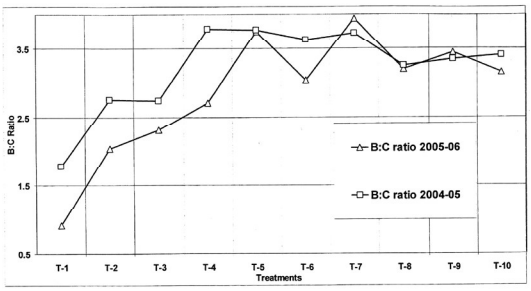

Figure 1. Benefit to cost ratio of manure and fertilizer application in sorghum-greengram based cropping system.

of organic manure addition was attributed to not only release of Zn from decomposed organic manure but even solubalization of native precipitated Zn by chelation with organic colloids.

B : C Ratio

For the sake of clarity, B:C ratio and economics of crop cultivation for only two years are presented in Figure 1. The B:C ratios and economics are calculated taking into account of both the *kharif* and *rabi* crops. Soil application of 5 t/ha FYM along with 100% RDF remained the best as it registered highest B:C ratio of 3.9 during 2004-05 and 2005-06 followed by 100% RDF.

Therefore, it is advisable to recommend application of 5 t/ha FYM/ha along with 100% fertilizer as this practice not only recorded higher economical returns but was sustainable. Soil fertility status and nutrient uptake (Zn) by crop remained higher with 10 t/ha FYM along with 50 or 100% RDF application.

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