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EFFECT OF INORGANIC FERTILIZERS AND FYM ON ONION PRODUCTIVITY AND SOIL FERTILITY

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ABSTRACT

A field experiment was carried out at research farm of A.S College, Lakhaoti, Bulandshahr (U.P.) during rabi season of 2008-09 and 2009-10 to evaluate the effect of chemical fertilizers and FYM on onion productivity and soil fertility. Results of a ten treatments field experiment revealed that the bulb yield increased by 73.1% with 150% NPK fertilizers over control. The combined application of chemical fertilizer and FYM significantly increased the bulb yield of onion (69.2%) as compared to control. Maximum bulb yield (37.59 t ha^{-1}) was recorded with conjoint use of 100% NPK + 10 t FYM ha^{-1} + 6 kg Zn + 20 kg S ha^{-1} which was 87.5% higher than control. Combined application of 100% NPK + 10 t FYM + 20 kg S + 6 kg Zn ha^{-1} gave significantly higher values of organic carbon (4.0 g kg^{-1}), available N (180.3 kg ha^{-1}), P (9.8 kg ha^{-1}) and K (160.0 kg ha^{-1}) in post harvest soil. Available S and DTPA-extractable Zn were found to be higher in the treatment combination of 100% NPK + 10 t FYM + 20 kg S ha^{-1} and 100% NPK + 10 t FYM + 6 kg Zn ha^{-1}, respectively. The minimum amounts of organic carbon and available nutrients were recorded under control treatment.

Keywords: Inorganic fertilizers, FYM, onion productivity, soil fertility.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops grown in India. Increasing productivity of onion with high quality is an important target by the onion growers. Lack of manuring and balanced fertilization is one of the important causes of low yield. Onion requires substantial amount of plant nutrients and responds very well to the added nutrients (Verma et al. 2010). Sulphur and zinc deficiencies and neglect to give equal importance to these nutrients in fertilization programme has resulted in low productivity of onion. Sulphur, as a plant nutrient, is becoming increasingly important in Indian agriculture due to its wide spread deficiency. It plays an important role in the formation of S containing amino acids, synthesis of proteins and is also associated with nitrogen metabolism. Nutritional disorder impairs its quality. Enhanced use of chemical fertilizers for increasing vegetable production has been widely recognized (Singh and Singh,1995) but their indiscriminate use may have adverse effect on soil health, ecology and other natural resources. The high cost of fertilizers also restricts their large scale use. Therefore, to reduce the dependence on chemical fertilizers and maintenance of high production levels are vital issues in modern agriculture which is only possible through conjoint use of chemical fertilizers and FYM. Use of organic manures help in mitigating the multiple nutrient deficiencies. Hence, integrated use of FYM with chemical fertilizers holds great improvement in bulb crops like onion to conserve the soil health and to get good yield. Hence, an attempt was made to evaluate the response of onion to application of FYM and chemical fertilizers on yield and soil fertility.

MATERIALS AND METHODS

Field experiments were conducted at Amar Singh College Research Farm Lakhaoti (Bulandshahr) during *rabi* season of 2008-09 and 2009-10. The soil of the experimental field was sandy loam in texture with pH 7.8, organic carbon 2.9 g kg^{-1} and available N, P, K, S and Zn 140, 9.5, 120, 15 kg ha^{-1} and 0.55 mg kg^{-1}, respectively. The experiment included 10 treatments viz. T_1 control, T_2 100% NPK (150 kg N + 100 kg P_2O_5 + 50 kg K_2O ha^{-1}), T_3 100% NPK + 6 kg Zn ha^{-1}, T_4 100% NPK + 20 kg S ha^{-1}, T_5 100% NPK + 10 t FYM ha^{-1}, T_6 100% NPK + 6 kg Zn + 20 kg S ha^{-1}, T_7 100% NPK + 6 kg Zn + 10 t FYM ha^{-1}, T_8 100% NPK + 20 kg S + 10 t FYM ha^{-1}, T_9 100% NPK + 6 kg Zn + 20 kg S + 10 t FYM ha^{-1} and T_{10} 150% NPK each replicated three times in a randomized block design. Potassium in the form of muriate of potash was applied at planting but the crop received N in two splits, half as basal and half at 60 days after planting. Phosphorus was applied as triple superphosphate at planting. Zinc and sulphur were applied as zinc chloride and elemental sulphur at the time of planting, respectively. The seedlings of onion cv. Nasik red N-53 were planted in mid December during both the years. Crop was harvested at physiological maturity and yield data were recorded. The soil samples were collected after harvest of onion from 0-15 cm depth and analyzed for different parameters by following standard procedures for organic carbon (Walkley and Black 1934), available N (Subbiah and Asija 1956), available P (Olsen *et al.*

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1954), available K (Muhr *et al.* 1965), available S (Chesnin and Yien 1951) and available Zn (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

Yield

Yield data have been pooled and presented in Table 1. It indicates that highest average yield of onion bulb (37.56 t ha^{-1}) was obtained with optimum dose (100%) NPK applied in conjunction with FYM + S + Zn (T_9) and the lowest yield (20 t $ha^{-1)}$ in control. Use of 100% NPK alone had increased the bulb yield by 57.1% over control. The difference in increase obtained in the bulb yield of onion at 100% NPK (57.1%) and 150% NPK (73.1%) indicates the superiority of super optimal dose apparently because the yield may be economically increased. Use of optimal dose of fertilizer in conjunction with FYM resulted in 69.2% increase in onion yield over control as compared to 73.1% increase in super optimal dose. Similar results were reported by Singh and Pandey (2006) and Verma et al. (2010). Application of 100% NPK + 20 kg S ha^{-1} increased the bulb yield significantly by 63.3% over control. The increase in bulb yield was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application Verma and Singh (2012) reported increased bulb yield due to sulphur application. Yield of onion bulb was improved with the integrated use of 100% NPK + FYM + S + Zn by 87.5 % over control. These findings indicate that integrated use of 100% NPK and manure proved to be better proportion over use of super optimal dose indicating the benefits of integrated use of fertilizers and manure.

Soil fertility

Organic carbon content of the soil, which was 2.9 g kg^{-1} in the initial sample, had increased in all the treatments and the highest value (4.0 g kg^{-1}) was recorded in 100% NPK + FYM + Zn + S (T_9) treatment (Table 2). This shows that use of fertilizers along with manures helps in increasing the organic carbon content of the soil. The findings are in conformity with Tiwari et al. (2002). This increase in organic carbon content due to use of fertilizers and manures can be attributed to higher contribution of biomass to the soil in the form of crop residues. However, the differences in the organic carbon content due to application of various treatments might be the result of differential rate of oxidation of organic matter by microbes. Available N status of the soil improved significantly with both the levels of NPK fertilizers, the increase being 51 kg ha^{-1} in 150 % NPK treatment as compared to the initial value (129.3 kg ha^{-1}). Increase in available N due to graded application of NPK fertilizers has also been reported by Tiwari et al. (2002). Addition of 10 t FYM ha^{-1} + 6 kg Zn or 20 kg S ha^{-1} also improved the status of available N in soil over control which may be attributed to increased availability of nitrogen in soil due to application of inorganic fertilizers and FYM. The higher value of available nitrogen was recorded at 10 t FYM ha^{-1} + 100% NPK indicating the beneficial effect of combined use of organic manure and fertilizers. Singh and Pandey (2006) reported similar results. Available N status of the soil also improved with T_6, T_7 and T_8 treatments indicating beneficial effect of integrated use of organic manure and chemical fertilizers. Organic manure (10 t FYM ha^{-1}) addition along with S and zinc also enhanced the available N over control (Singh and Singh 1995). The maximum and minimum values of available nitrogen content in soil were recorded under T_9 and control treatment, respectively. This showed an increase over initial value clearly indicating the benefits accruing from integrated use of fertilizers and manures which is also evident from the yield data. These findings are in line with the findings of Tiwari *et al.* (2002) who observed that available N and P content in soil increased significantly with the use of fertilizers and manure.

Table 1: Effect of various treatments on bulb yield (t ha^{-1}) of onion (mean of 2 years)

Treatments	Bulb yield	% response
T_1 control	20.00	-
T_2 100% NPK	31.42	57.1
T_3 100% NPK + 6 kg Zn ha^{-1}	33.07	65.3
T_4 100% NPK + 20 kg S ha^{-1}	32.65	63.3
T_5 100% NPK + 10 t FYM ha^{-1}	33.83	69.2
T_6 100% NPK + 6 kg Zn + 20 kg S ha^{-1}	34.51	72.5
T_7 100% NPK + 6 kg Zn + 10 t FYM ha^{-1}	35.30	76.5
T_8 100% NPK + 20 kg S + 10 FYM ha^{-1}	35.68	78.4
T_9 100% NPK + 6 kg Zn + 20 kg S + 10 t FYM ha^{-1}	37.56	87.5
T_{10} 150% NPK	34.62	73.1
CD (P=0.05)	1.91	

Available phosphorus status in soil increased with all the treatments over control. There was a significant increase in available P content in soil with increasing levels of NPK fertilizers and relatively higher amount was noted in 150% NPK level. This may be attributed to the increased amount of P in soil due to application of phosphatic fertilizer. Addition of 6 kg Zn along with 100% NPK reduced the available P content over 100% NPK alone. But addition of 20 kg S ha^{-1} or 10 t FYM ha^{-1} along with 100% NPK fertilizers improved the status of available P in soil after the harvest of onion crop. The magnitude of increase was greater in 10 t FYM ha^{-1} + 100% NPK treatments than that of 20 kg S ha^{-1} + 100% NPK dose. The relatively higher value of the available P content under 10 t FYM ha^{-1}+ 100% NPK treatment may be accounted for by the fact that most of the P in FYM exists in an inorganic and available form and that the organic P present is fairly and quickly mineralized in soil. The results are in conformity with the findings of Singh and Pandey (2006). Available P content in soil also improved with T_5 (Zn + S), T_6 (Zn + FYM) and T_7 (S + FYM) treatments over control. Application of 10 t FYM along with 6 kg Zn and 20 kg S ha^{-1} (T_8) also improved the status of available P in soil which may be ascribed to the solubilization effect of organic acids liberated during the decomposition of organic matter. These results are in conformity with the findings of Tiwari *et al.* (2002) who attributed the appreciable increase in available P content of soil to the influence of organic manure which could have enhanced the labile P in soil by complexing the cations like Ca, Mg and Al responsible for the fixation of phosphorus.

Table 2: Effect of various treatments on organic carbon, available N, P, K, S and Zn in soil after harvest of the crop (mean of 2 years)

Treatments	Org. C (g kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (kg ha^{-1})	Available Zn (mg kg^{-1})
T_1	2.6	129.3	7.4	100.0	13.8	0.53
T_2	2.8	152.6	8.2	140.5	14.3	0.55
T_3	2.9	148.2	7.4	137.5	14.0	0.66
T_4	2.9	153.5	7.9	140.0	18.1	0.55
T_5	3.4	174.1	8.7	155.0	16.0	0.57
T_6	3.0	154.1	8.0	133.5	17.0	0.65
T_7	3.6	172.5	7.9	155.0	16.2	0.69
T_8	3.8	178.8	9.3	157.2	18.2	0.66
T_9	4.0	180.3	9.8	160.0	18.5	0.71
T_{10}	3.0	177.0	8.4	155.6	14.6	0.56
SEm $\pm$	0.11	5.4	0.31	7.0	0.20	0.07
CD (P=0.05)	0.23	11.3	0.65	14.65	0.41	0.14

Increasing levels of NPK fertilizers improved the status of available K in soil after the harvest of onion crop over control. The highest level (150% NPK) proved more beneficial in respect of available K content in soil. In the presence of 100% NPK level, the amount of available K in the soil also improved significantly with both 20 kg S ha^{-1} or 10 t FYM ha^{-1}. The magnitude of increase in available K status was more with FYM than that of sulphur. The amount of available K in soil also improved with combined application of S and zinc, S and FYM and Zn and FYM over S and Zn alone treatments. But the differences were statistically non-significant between these treatments. Application of 10 t FYM alongwith 6 kg Zn + 20 kg S ha^{-1} (T_8) also improved the status of available K over control. Application of FYM increased organic colloids, which probably caused greater adsorption of K^+ from the soil solution. Application of organic matter with fertilizer alleviated available K status of the soil. FYM containing K_2O when applied for two years is bound to enrich the K status of the soil. Besides this native K becomes more available due to the action of organic acids liberated during the decomposition of organic matter. Bellakki et al. (1998) and Singh and Singh (1995) reported that application of N and FYM in combination improved the status of available K in soil.

Data on available sulphur content (Table 2) clearly show that available sulphur content in treatment devoid of applied S and control was lower than the initial value indicating that sulphur shoul be an important ingredient in fertilizer schedule. The reduction in soil sulphur as a result of cropping could possibly be due to continuous absorption of sulphur by the crop plants from the native soil source. There was a significant build up of available sulphur in soil due to different treatments and maximum value of available sulphur content in soil was recorded under 100% NPK + 10 kg Zn + 10 t FYM + 20 kg S ha^{-1} (T_8) treatment. There was a significant increase in available sulphur with increasing levels of NPK (100% to 150%) fertilizers. All the integrated combinations of nutrients exhibited higher available sulphur content in soil as compared to control and 100% NPK fertilizers. This is an indication of the sulphur supplying capacity of FYM and elemental sulphur. Increased availability of S in soil by the addition of organic manures has been reported by Sinha and Sakal (1993). Available zinc status depleted under control which may be attributed to higher uptake of native zinc by the crop. Application of NPK levels and S slightly improved the status of available Zn over control. Available Zn content in soil increased significantly over initial status under 6 kg Zn ha^{-1} or 10 t FYM ha^{-1}. The increase in the former treatment appears to be due to zinc application and in the latter due to mineralization of organically bound forms of Zn in the FYM and also it might result in the formation of organic chelates of higher stability, because zinc is known to form relatively stable chelates with organic ligands which decreased their susceptibility to adsorption, fixation and /or precipipitation. Similar results were reported by Singh and Singh (1995).

The above results indicated that application of integrated use of optimal fertilizer dose with organic manure was successful in maintaining high level of onion productivity and in the maintenance and improvement of soil fertility. Further, the importance of inclusion of sulphur and zinc in fertilizer schedule is also highlighted by these results as treatment devoid of sulphur and zinc did exhibit deleterious effect on available sulphur and zinc status of the soil as well as crop productivity.

REFERENCES

Bellaksi, M.A. Badanur, V. P. and Sotty, R.A. (1998) Effect of long term integrated nutrient management on some important properties of vertisol. *Journal of the Indian Society of Soil Science* 46: 176-180.

Chesnin, L. and Yien, C.H. (1951) Turbidimetric determination of available sulphate. *Soil Science Society of America Proceeding* 15: 149-151

Jat, G., Sharma, K.K. and Jat, V.K. (2012) Effect of FYM and mineral nutrients on physic-chemical properties of soil under mustard in western arid zone of India. *Annals of Plant and Soil Research*. 14: 167-170.

Kher, D. (1993) Effect of continuous liming, manuring and cropping on DTPA- extractable micro nutrients in an alfisoil. *Journal of the Indian Society of Soil Science* 41: 366-367

Lindsay, W.L. and Norvell, W.A. (1978) Development of a DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal* 42: 421-428.

Muhr, G.R., Datta, N.P., Shankar, Subaramoney, H. Leley, V.K. and Donahue, R.L. (1965) *Soil testing in India*. U.S. Agency for international development, New Delhi, p.p.20

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954) Estimation of available phosphorus in soils extraction with sodium bicarbonate. *United States Department of Agriculture Circular*, 939, pp 19.

Singh, V. and Pandey, M. (2006) Effect of integrated nutrient management on yield of and nutrient uptake by onion and on soil fertility. *Journal of the Indian Society of Soil Science* 54: 365-367.

Singh, V. and Singh, R.K. (1995) Response of onion (*Allium cepa* L.) to N, P, Zn and FYM. *Annals of Agricultural Research* 16: 79-81

Subbiah, B.V. and Asija, G.L. (1956) A rapid procedure for the estimation of the available nitrogen in soil. *Current Science* 25: 259-260.

Tiwari, A., Dwivedi, A.K. and Dikshit, P.R. (2002) Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean -wheat system in a vertisol. *Journal of the Indian Society of Soil Science* 50: 472-475.

Verma, D. and Singh, H. (2012) Response of varying levels of potassium and sulphur on yield and uptake of nutrients by onion. *Annals of Plant and Soil Research*. 14: 143-146.

Verma, D., Singh, D. and Singh, H. (2010) Effect of nitrogen and potassium on yield and uptake of nutrients by onion. *Annals of Plant and Soil Research* 12: 48-49.

Walkley, A. and Black, C.A. (1934) An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method *Soil Science*. 37: 29-38.