Annals of Plant and Soil Research 19(2):180 - 184 (2017)

Effect of FYM and manganese on yield and uptake of nutrients by onion *(Allium cepa L)* in an alluvial soil

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Received: January, 2017, Revised accepted: April, 2017

ABSTRACT

A field experiment was conducted at R.B. S. College, Research Farm Bichpuri, Agra (U.P.) during rabi season of 2012-13 and 2013-14 to study the effect of FYM and manganese on yield and uptake of nutrients by onion (Allium cepa L) in an alluvial soil. The treatments consisted of four levels each of FYM (0, 5, 10 and 20 t ha^{-1}) and manganese (0,5,10 and 20 kg ha^{-1}) were laid out in randomized block design with three replications. The results revealed that the scale leaves, bulbs/plot, fresh weight of onion bulb, bulb yield and bulb dry matter yield increased linearly up to10 kg Mn ha^{-1} and 20 t FYM ha^{-1}. The bulb yield (32.28 t ha^{-1}) at 10 kg Mn ha^{-1} was 9.0% higher than that obtained in the control. Application of 20 t FYM ha^{-1} gave the highest yield of bulb (34.95 t ha^{-1}), which was 37 % more in comparison with that of the control. Similarly, dry matter yield of onion bulbs increased significantly with increasing levels of FYM up to 20 t ha^{-1} and up to 10 kg Mn ha^{-1}. The crop quality in respect of protein content also improved with FYM and manganese application. The uptake of nutrients by onion crop increased significantly with FYM application over control. The uptake of N and Mn by onion bulbs significantly increased up to 10 kg Mn ha^{-1} and 20t FYM ha^{-1} over respective controls. The manganese application also had a significant beneficial effect on the utilization of K, P and S by the onion crop. The onion crop gave maximum net returns (Rs 105456 ha^{-1}) and income per rupee spent (2.64) with 20 t FYM ha^{-1}. The maximum net returns (Rs 96025 ha^{-1}) and B:C ratio (2.52) were recorded with 10 kg Mn ha^{-1}.

Key words: - FYM, manganese, yield, nutrient uptake, soil fertility, onion.

INTRODUCTION

Onion is one of the most important commercial vegetable crops grown in India. Onion has culinary, dietary and medicinal importance in daily life of Indian people and due to its export trade, it is also a major vegetable crop to gain foreign currency. In India, the productivity of onion is very low due to lack of manuring and imbalanced fertilization. Use of optimum fertilization is the key factor in increasing the productivity which can be realized with the judicious application of plant nutrients to onion crop. Manganese is an integral component of the water splitting enzymes associated with photosystem II. It is a constituent of superoxide dismutase (Mn-SOD). Manganese acts as an important cofactor for a number of key enzymes involved in lignin synthesis. This function of Mn is reported to play a key role in imparting resistance to diseases. Manganese plays a role in the synthesis of carotenoids chlorophyll, gibberellic acid, sterols and quinines. Manganese deficiency occurs in well drained light textured soils with neutral or alkaline in reaction. Judicious use of farmyard manure with chemical fertilizers improves soil physical, chemical and biological properties and improves crop productivity. It also helped in arresting the emerging deficiencies of macro, secondary and micronutrients favorably and achieving economy and efficiency in fertilizers use. In view of shrinkage of land resources for cultivation, short supply and escalating cost of chemical fertilizers, environmental pollution and ill effects on soils, animals and human health, there is need to use farmyard manure with manganese fertilizers for achieving the objective of environmentally and ecologically sustainable agriculture (Verma *et al.* 2014). Limited studies have been conducted to work out the optimum proportion of organic manure and manganese for vegetable crops in Agra region. The present investigation was, therefore, carried out to study the effect of farmyard manure and manganese on yield, nutrient uptake and quality of onion.

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MATERIALS AND METHODS

A field experiment was carried out at Raja Balwant Singh College, Research Farm Bichpuri, Agra (U.P.) during rabi season of 2012-13 and 2013-14. The soil of the experimental field was sandy loam in texture with pH 8.2, organic carbon 4.2 gkg^{-1} and available N,P,K,S and Mn 170, 9.8, 102, 16.5 kg ha^{-1} and 2.6 mg kg^{-1}, respectively. The treatments comprised all combinations of four levels each of FYM (0, 5, 10, and 20 t ha^{-1}) and manganese (0,5,10 and 20 kg ha^{-1}). There were thus, 16 treatment combinations which were replicated thrice in randomized block design. The recommended dose of nitrogen, phosphorous and potassium (200, 100 and 100 kg ha^{-1}) were supplied through urea, di ammonium phosphate and muriate of potash, respectively at transplanting time. The calculated amount of FYM and Mn (manganese chloride) were supplied well before transplanting. The seedlings of onion (var. Nasic Red N-53) were planted at 20 x 15 cm spacing in mid-December during both the years. The crop was harvested at physiological maturity and yield data were recorded. The bulb samples were digested with di acid mixture of HNO_3 and $HClO_4$ in 9:1 ratio. Phosphorus was determined by vanadomolybdo phosphoric acid yellow colour method (Jeckson 1973), S by turbidimetric method (Chesnin and Yien 1951), K by flame photometer, Mn by atomic absorption spectrophotometer. Nitrogen in bulbs was determined by modified micro-kjeldahl method. The nutrient uptake was calculated by multiplying the concentration values with the respective dry matter yield data. Soil samples collected after harvest were analyzed for available nutrients by adopting standard procedures (Jackson, 1973).

RESULTS AND DISCUSSION

Yield attributes and yield

The maximum number of scale leaves per bulb was recorded at 20t FYM ha^{-1} which was significantly superior to 10t FYM ha^{-1} and absolute control (Table 1). Manganese application showed significant influence on the number of scale leaves per bulb. The increase in number of scale leaves per bulb was significant up to 10 kg Mn ha^{-1}. Thereafter, a reduction in number of scale leaves was recorded at 20kg Mn ha^{-1} over 10 kg Mn ha^{-1}. The number of bulbs per plot was affected significantly by the application of FYM and highest number was recorded at 20 t FYM ha^{-1} (Verma *et al.* 2014). The increase in number of bulbs per plot was significant up to 10 kg Mn ha^{-1} over control. Thereafter, a reduction in number of bulbs per plot was recorded at 20 kg Mn ha^{-1} treatment.

Table 1: Effect of manganese and FYM on yield quality and economics of onion (mean of 2 years)

Treatment	Scale leave	Bulbs/plot	Bulb yield (t ha^{-1})	Dry matter yield (t ha^{-1})	Protein content (%)	Net return (Rs ha^{-1})	B/C Ratio
Manganese (kg ha^{-1})							
0	26.7	92.3	29.6	4.74	4.33	81900	2.47
5	28.0	93.3	31.3	5.00	4.44	90711	2.52
10	29.2	94.8	32.2	5.16	4.55	96025	2.92
20	28.7	93.6	30.6	4.95	4.59	91075	2.31
SEM ±	0.32	0.66	0.15	0.03	0.027		
CD (P = 0.05)	0.94	1.93	0.43	0.10	0.078		
FYM (t ha^{-1})							
0	26.00	92.25	25.4	4.13	3.91	19496.25	1.62
5	27.78	92.84	30.2	4.84	4.44	28877.50	1.90
10	29.00	94.70	33.1	5.30	4.70	33881.25	2.02
20	30.00	96.42	34.9	5.59	4.84	35456.25	2.03
SEM ±	0.32	0.668	0.15	0.03	0.027		
CD (P = 0.05)	0.94	1.930	0.43	0.10	0.078		

The bulb yield of onion increased significantly with increasing levels of FYM. The increases in bulb yield due to 5. 10 and 20 t FYM ha^{-1} over absolute control (no FYM) were 18.8, 30.1. and 37.2 %, respectively. The magnitude of increase in bulb yield with 20 t FYM ha^{-1} was higher as compared to 10 t FYM ha^{-1}. The beneficial effect of farm yard manure may be due to its contribution in supplying additional plant nutrients, improvement of soil physical condition and biological processes in soil (Singh and Pandey, 2006). The increase in bulb yield with FYM was also reported by Singh *et al.*(2015). The bulb yield of onion increased significantly with increasing levels of manganese up to 10 kg ha^{-1} but further increase in Mn level up to 20 kg ha^{-1} had an adverse effect on the bulb yield. The increases in bulb yield due to 5, 10, and 20 kg Mn ha^{-1} over absolute control (no manganese) were 5.5, 8.9 and 3.3 percent; respectively.The similar results have also been reported by Choudhary (2010). The dry matter yield of onion bulbs increased significantly with increasing levels of FYM. The mean dry matter yield increased from 4.13 t ha^{-1} at control to 5.59 t ha^{-1} with 20 t FYM ha^{-1} (Singh *et al.* 2015). Dry matter yield of onion bulb also increased significantly with increasing levels of manganese up to 10 kg ha^{-1}. Thereafter, a reduction in dry matter yield of onion bulbs was noted at 20 kg Mn ha^{-1}. The increase in dry matter yield was from 4.74 t ha^{-1} in control to 5.16 t ha^{-1} with 10 kg Mn ha^{-1}. The increase in dry matter production with increasing manganese levels was also reported by Singh and Singh (2007).

Quality

Protein content in onion bulbs ranged from 4.33% at control to 4.59 % with 20 kg Mn ha^{-1}. This increase in protein content with Mn application is due to increase in N content. Similar results were reported by Choudhary (2010). There was a significant increase in protein content with increasing levels of FYM and maximum value (4.84%) was recorded with 20 t FYM ha^{-1}.This increase in protein content with FYM may be attributed to increased availability of N in soil for the crop, resulting in higher N content and an ultimate increase in protein content. Positive effect of FYM on protein content has also been reported by Singh *et al.* (2015).

Economics

The highest net returns of Rs. 105456 and Rs 96025 were obtained with 20 t FYM ha^{-1} and 10 Mn ha^{-1} in onion crop, respectively. In the light of this, it can be argued that more bulb production with this treatment may be the reason for the resultant profits. The income per rupey spent (B/C ratio) was highest (2.64) with 20 t FYM ha^{-1} and (2.52) with 10 kg Mn ha^{-1} from the crop of onion. It is due to more net returns that the cost of cultivation involved with this treatment. The B:C ratio was minimum due to onion in control (Singh *et al.* 2015). On the basis of net returns and B:C ratio, it may be inferred that to get maximum returns and benefit : cost ratio from onion, the crop should be grown with 20 t FYM ha^{-1} + 10 kg Mn ha^{-1} by the farmers of Agra region under existing agro climatic conditions.

Table 2: Effect of manganese and FYM on uptake N, P, K, S (kg ha^{-1}), Mn (g ha^{-1}) by onion bulbs and available nitrogen (kg ha^{-1}), available Mn (mg kg^{-1}) in soil (mean of 2years)

Treatmet	N	P	K	S	Mn	Available N	Available Mn
Manganese (kg ha^{-1})							
0	33.1	9.5	34.1	13.4	434.5	214.2	2.28
5	35.8	10.5	35.6	14.6	530.7	215.5	2.65
10	37.7	11.0	36.1	14.2	627.2	212.2	2.93
20	36.7	10.3	34.1	13.0	673.7	216.3	3.17
SEM ±	0.31	0.18	0.60	0.32	4.66	2.93	0.04
CD (P = 0.05)	0.89	0.54	NS	0.94	13.48	NS	0.12
FYM (t ha^{-1})							
0	25.8	6.3	26.4	9.2	445.2	135.7	2.40
5	34.3	9.3	33.2	13.1	548.0	191.1	2.60
10	39.8	12.3	38.5	15.3	613.9	239.2	2.79
20	43.3	13.5	41.6	17.6	658.9	292.1	3.23
SEM ±	0.31	0.18	0.60	0.32	4.66	2.93	0.04
CD (P = 0.05)	0.89	0.54	1.74	0.74	13.48	8.48	0.12

Nutrient uptake

The application of FYM increased the nitrogen uptake (Table 2) by onion bulbs significantly over the control. The crop grown with FYM levels (5, 10 and 20 t ha^{-1}) utilized 8.5, 14.0 and 17.4 kg ha^{-1} greater N, respectively than those grown with no FYM. All the levels of FYM proved significantly superior over control in respect of nitrogen uptake by onion bulbs. The maximum value of N uptake by onion bulbs were recorded at 20 t FYM ha^{-1}. The application of manganese increased nitrogen uptake by onion bulbs significantly over control. The onion grown with manganese levels (5, 10 and 20 kg ha^{-1}) utilized 2.70, 4.66 and 3.66 kg ha^{-1} greater N, respectively than those grown with no manganese. Thus, the maximum utilization of nitrogen by onion bulbs was noted at 10 kg Mn ha^{-1}. The improvement was mainly due to greater production of onion bulbs.Higher uptake of nitrogen with FYM indicate mineralized N from FYM could sufficiently meet the nutritional requirement of the crop. These results are in close conformity with those of Singh and Pandey (2006). The uptake of phosphorus by onion bulbs increased significantly with FYM application. All the levels of FYM proved significantly superior to control (no FYM) in respect of phosphorus uptake by onion bulbs. The maximum values of phosphorus uptake by onion bulbs were recorded with 20t FYM ha^{-1}. This increase in P uptake may be attributed to increased yield of bulbs (Verma *et al.* 2014).The maximum utilization of phosphorus by onion bulbs was noted at 10 kg Mn ha^{-1}. Thereafter, a reduction was noted at 20 kg Mn ha^{-1}. Similar results were reported by Reshi and Singh (2009). FYM application affected the utilization potassium by onion bulbs significantly over control. All the levels of FYM proved beneficial over the control in respect of potassium uptake by the onion bulbs. The increase in potassium uptake by onion bulbs due to 5, 10 and 20 t FYM ha^{-1} levels over control were 6.8, 12.1 and 15.2 kg ha^{-1} respectively. This increase in the utilization of K by onion bulbs with FYM application is obvious as it is considered as a store house of plant nutrients (Pachouri *et al.* 2005). The uptake of potassium by onion bulbs increased with manganese application but the effect of Mn levels on K uptake was statistically non significant. The utilization of sulphur by onion bulbs increased significantly with FYM application. The increase in sulphur uptake due to 5, 10 and 20 t FYM ha^{-1} over control were 3.8, 6.0, and 8.3 kg ha^{-1}, respectively. Similar increase in S uptake by the crop was also reported by Verma *et al.* (2014). Manganese application also proved beneficial in as much as it enhanced the sulphur uptake by the onion bulbs significantly. The maximum value of S uptake was noted with 5 kg Mn ha^{-1} followed by a reduction at higher levels. Application of FYM increased the manganese uptake by onion bulbs significantly over control. The manganese uptake by the crop increased by 102.8, 168.7 and 213.7 g ha^{-1} more over control with 5, 10 and 20 t FYM ha^{-1}, respectively. Application of Mn significantly increased its removal by onion bulbs over control and this effect was observed with all the levels of applied Mn. This increase in Mn uptake by the crop was consistent upto 20 kg Mn ha^{-1} level.This increase in Mn uptake may be attributed to increased its availability in soil (Choudhary 2010). From the present investigation, it may be inferred that application of 20 t FYM ha^{-1} and 10 kg Mn ha^{-1} in onion resulted in higher yield, quality and uptake of nutrients. Thus, application of 20 t FYM ha^{-1} and 10 kg Mn ha^{-1} appears to the best doses of FYM and Mn for obtaining higher yield and net profits from onion under agro- climatic condition of Agra (Uttar Pradesh).

Soil fertility

The amount of available nitrogen in soil after crop harvest was affected significantly with different levels of FYM application. The amount of available N in soil increased from 135.7 to 292.1 kg ha^{-1} as the dose of FYM increased from 0 to 20 t FYM ha^{-1}. On the other hand, the amount of available nitrogen in soil significantly with levels of Mn application. There was a significant increase in available Mn content in soil with increasing levels of FYM. The amount of available Mn increased from 2.40 to 3.23 mg kg^{-1} with 20 t FYM $ha^{-1.}$ Available Mn content also increased significantly with each increase in the level of Mn from control to 20 kg Mn ha^{-1}. Thus, the maximum amount of available Mn was obtained under 20 kg Mn ha^{-1} which proved significantly superior to all levels of Mn. This increase may be attributed to increase available of Mn in post harvest soil due to its application (Singh and Singh 2007).

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