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P Venkata Subbaiah
Assistant Professor, Department of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla, Andhra Pradesh, India

A Sai Ram
Assistant Professor, Department of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla, Andhra Pradesh, India

P Chandra Sekhara Rao
Assistant Professor, Department of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla, Andhra Pradesh, India

A Siva Sankar
Assistant Professor, Department of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla, Andhra Pradesh, India

Corresponding Author:
P Venkata Subbaiah
Assistant Professor, Department of Soil Science & Agricultural Chemistry, Agricultural College, Bapatla, Andhra Pradesh, India

Cumulative and residual effect of *kharif* maize fertility treatments on growth & nutritional quality of vegetable onion

P Venkata Subbaiah, A Sai Ram, P Chandra Sekhara Rao and A Siva Sankar

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Abstract
A field experiment is conducted to study the direct, cumulative and residual effect of fertility treatments on vegetable onion. The results revealed that the highest dry matter, N, P, K & S and micro nutrient content and uptake both in leaf and bulb under fertilized cumulative field condition. Vegetable onion grown on preceding maize fertility treatments shown significant variation in growth and nutrient content among the direct, cumulative and residual strips. Vegetable onion responded well under integrated use of organic and inorganic source of nutrients and biofertilizer treatments of preceding maize both under cumulative and residual treatments over other inorganic sources of nutrients to preceding maize crop.

Keywords: Vegetable onion, nutritional quality, residual nutrients, cumulative nutrient effect

Introduction
Vegetables form an important part of the human diet of rural and urban people alike as they are rich sources of carbohydrates, fats, minerals and vitamins. Onion (*Allium cepa* L.) is one of the major bulbous crops of the world and one of the most important commercial vegetable crops grown in India. It occupies an area of 0.83 million hectares with a total production of 13.56 million tons with an average yield of 126.5 q ha^{-1}. In Andhra Pradesh it is grown in area of 0.039 million hectares with a production of 0.06 million tons with an average yield 160.0 q ha^{-1} (CMIE 2009). In Andhra Pradesh, the practice of using harvested young onion plants as salad and curry is in very wide scale in both urban and rural areas. The growth and nutritional quality of leaf and bulb at 30 DAT having significant dietary importance.
Concern for conservation of non –renewable energy, sustainable agriculture and fertilizers induced pollution forced the agricultural scientists to look for complete or part substitution of fertilizers. Organic manures are used for substituting the inorganic fertilizer to some extent. According to principles of INM, at least 30 per cent of the nutrient requirement of crop should be organic form. Unlike N, the P has marked residual effect on the succeeding crops due to its low recovery by the first crop and its rapid conversion into various P fractions. This indicates the possibility of economizing the expenditure on phosphate fertilizers by scheduling fertilizer on the basis of crop sequence rather than on individual crop basis. Several investigations revealed that, the usefulness of integrated nutrient sources in benefitting the succeeding crop through their residual influence. Nonetheless, the application of inorganic nutrients in adequate quantities has also been documented to enhance the soil quality. The benefits of enhanced soil quality may exploited the by the succeeding crop to improve the productivity either through residual effects or cumulative effects. Keeping in view the present study is carried out to study the direct, cumulative and residual effects of nutrients on succeeding onion crop.

Material and Methods
A field experiment was conducted to know the, Direct, Residual and cumulative nutrient effects on *Rabi* onion crop at College Farm, College of Agriculture, Rajendranagar, Hyderabad, after harvest of *Kharif* maize crop. The *Kharif* maize nutrient treatments consisted control(T_1); three inorganic N and P levels 50% N and P through RDF (T_2), 75% N and P through RDF(T_3) and 100% N and P through RDF(T_4) and integrated nutrient management

treatments *viz*., 75% N through RDF + 25% N through poultry manure(T_5), 75% N through RDF + 25% N through poultry manure + azotobacter (T_6), 75% N through RDF + 25% N through vermicompost (T_7), 75% N through RDF + 25% N through vermicompost + azotobacter (T_8), 75% P through RDF + 25% P through poultry manure (T_9), 75% P through RDF + 25% P through poultry manure + phosphorus solubulising bacteria (T_{10}), 75% P through RDF + 25% P through vermicompost (T_{11}), 75% P through RDF + 25% P through vermicompost + phosphorus solubulising bacteria (T_{12}). The organic sources of nutrients and biofertilizers were applied at the time of field preparation to maize. After harvest of maize in *rabi* season onion grown in strip plot design by dividing the plot in to two equal halves to know the cumulative and residual effect of *Kharif* crop treatments on *Rabi* onion, all the plots were divided into two equal halves. Fertilizers were not applied to one half to know the residual effect on onion grown during *Rabi* after harvest of maize crop. In another half a common dose of 75 percent of recommended dose of N, P and K fertilizers were applied to onion crop for all the treatments to know the Direct and cumulative effect. The soil and plant samples were collected after harvest of each crop and analyzed for nutrient contents by following standard methods (Piper 1966, Jackson, 1973) [4, 2].

Cumulative and Residual effect on dry matter, concentration of N, P, K, S, Fe, Mn, Zn and Cu and their uptake by onion leaves at 30 days after transplanting.

The data on dry matter accumulation, concentration of N, P, K and S and their uptake by the leaves of onion at 30 days after transplanting is presented in table 1. The untreated onion accumulated less dry matter compared to the treated onion for any set of treatment comparisons due to different levels of fertility imposed on the preceding maize. Dry matter accumulation of 2.30 q ha^{-1} was recorded in the leaves of onion due to the direct effect of fertilizer application. The cumulative influence from the residual fertility of N and P fertilizer application to maize and the direct effect of fertilizers application to onion significantly increased the leaf dry matter to 4.22 q ha^{-1}. The cumulative effect due to the integrated nutrient management treatments to maize and fertilizer application to onion was on par with the inorganic fertilizer application to both the crops.

The untreated onion responded significantly to produce large quantity of 3.21 q ha^{-1} dry matter due to the residual fertility of N and P fertilizers applied to maize compared to 1.88 q ha^{-1} by growing onion after the unfertilized maize. The residual fertility effect due to the integrated nutrient management treatments to maize was on par with the inorganic fertilizer application. The response pattern of the integrated nutrient management treatments over fertilizer application to maize was similar both to the cumulative and residual effect on the dry matter production in the leaves of onion.

The concentration of N was 1.03% in the leaves of onion due to the direct influence of fertilizer application, the cumulative effect of residual fertility due to the application of N and P fertilizers to maize and the direct effect of application of 75% NPK to onion significantly increased the N concentration to 1.27. The concentration of S increased from 0.31 to 0.34% due to the corresponding treatments. But, such differences were not recorded in case of P and K. The integrated nutrient management practices were similar in effect compared to fertilizer application to the maize crop for the concentration of N, P, K and S. There was no change in the concentration of N, P and K in onion leaves at 30 days after transplanting due to the residual fertility through different levels of fertilizer application or integrated nutrient management treatments to maize. But the crop responded to enrich its leaves with significantly larger concentration of 0.31% S due to the residual fertility of recommended level of N and P fertilizers applied to maize compared to control.

The residual fertility due to integrated nutrient management treatments was superior than the fertilizer application. There was a significant increase in the S concentration to the extent of 0.25-0.36%. The uptake of nutrients was 2.41 kg N, 0.37 kg P, 4.87 kg K and 0.72 kg S ha^{-1} in response to the direct influence of fertilizer application to onion. The cumulative effect due to the application of fertilizers both to maize and onion significantly increased the uptake of to 5.50, 0.71, 9.07 and 1.43 kg ha^{-1}. The integrated nutrient management treatments to maize further increased the uptake of P and S than the inorganic fertilizer application. The residual effect of fertilizer application to maize significantly increased the uptake of P, K and S. The integrated nutrient management treatments were relatively more effective. They increased the uptake of N, P, K and S through their residual influence compared to the inorganic fertilizer application, the response pattern due to the integrated nutrient management treatments through their cumulative effect and residual fertility were similar on the nutrient uptake.

The data on micronutrient concentration and their uptake in the leaves of onion at 30 days after transplanting is presented in table 2. The concentration of Fe, Mn, Zn and Cu was low in the unfertilized crop. The cumulative influence of different fertility levels to maize and fertilizer application to onion was on par with the direct effect of fertilizer application only to onion. The residual effect of different treatments to maize also did not exhibit a significant change in the concentration of these micronutrients compared to the unfertilized check. The leaves recorded an uptake of 3.10 g Fe, 2.11 g Mn, 1.87 g Zn, and 0.59 g Cu per hectare due to the direct effect of fertilizer application. The cumulative effect of fertilizer application to maize and onion significantly increased the uptake of these nutrients to 5.70, 3.89, 3.44 and 1.10 g ha^{-1}. The integrated nutrient management treatments were better than the fertilizer application to maize to significantly increase the uptake of Mn, Zn and Cu. The uptake of these micronutrients was significantly more in the leaves of unfertilized onion grown after the fertilized maize. The residual fertility of the integrated nutrient management treatments enhanced the uptake of Fe, Mn, Zn and Cu over the residual fertility through the fertilizer application. The response trend exhibited a significant improvement in the uptake of Fe, Mn and Zn due to the cumulative effect of integrated nutrient management treatments over the fertilizer application to maize compared to their residual influence on onion. Unlike maize, onion is a surface feeder of the nutrients because of its bulbous nature with fine roots mostly confined to a depth of 8-15 cm (Sharma, 2006) [7]. It is also a heavy feeder of available nutrients and respond well to their external application in sufficient quantities.

The crop exhibited a highly variable response to the direct, cumulative and residual level of fertility in the maize-onion cropping system at 30 days after transplanting. By this stage, it accumulated almost 1.3 to 2 times more dry matter in the leaves than the bulbs. The bulbs had relatively larger concentration of N and P while their uptake was more in the leaves. The concentration of K and S was almost similar both in the bulbs and leaves but their uptake was also more in the

leaves. The concentration of micronutrients *viz.*, Fe, Mn, Zn and Cu and their uptake was higher in leaves than the bulbs. Therefore, the young onion harvested for salad and curry preparation contain more nutritious leaves providing abundant quantity of nutrients for human health than the tiny bulbs.

The direct influence of fertilizer application only to onion in the maize-onion cropping system with 75% recommended level of 90-60-75 N, P_2O_5 and K_2O kg ha^{-1} was significantly superior in carrying over residual effect due to different fertility levels added to maize. The crop accumulated more dry matter, N, P, K, S, Fe, Mn, Zn and Cu concentration and hence higher uptake. The cumulative influence of increasing levels of N and P up to the recommended level of 120 kg N and 60 kg P_2O_5 ha^{-1} to maize and 75% recommended level of NPK to onion exhibited a strong cumulative effect than the residual and direct nutrient supplement to maximize the production of dry matter both in the bulbs and leaves. The concentration of N and K in the bulbs and only N in leaves increased significantly compared to direct fertilizer addition only to onion. But the uptake of N, P and K increased significantly due to the cumulative than the direct influence of fertilizer application both in the bulbs and leaves. The uptake of Fe, Mn, Zn and Cu also exhibited similar response only in the leaves. The integrated nutrient management treatments to maize and fertilizer application to onion signify the cumulative influence of nutrients as they further increased the production of onion bulbs significantly compared to the application of inorganic fertilizers to both the crops. Although the concentration of NPK remained on par, their uptake increased significantly due to integrated nutrient management treatments to maize and fertilizer application to onion. The bulbs were enriched in the concentration of sulfur and its total uptake. The uptake of Fe, Mn and Zn also increased significantly along with both the concentration and uptake of Cu. The residual fertility due to integrated nutrient management treatments to maize increased the bulb yield and the uptake of major and micronutrients. These results imply that the substitution of 25% N fertilizer with poultry manure or vermicompost supplied additional nutrients through mineralization through their slowly decomposing process and were made in the readily available inorganic forms both through their cumulative and residual effects. Although literature on carryover effect of these organics and the untreated crop during the preceding season and their utilization by onion is not available, ample evidences exist in other cropping systems like finger millet - maize-blackgram (Singaram and Kodandaraman,1992), maize-soybean (Reddy, 1997) [5], tomato- onion (Reddy, 1998) [6] maize-wheat (Parmar and Sharma, 2001) [3], maize-gobhi sarson (Anil Kumar *et al*., 2005) [1] soybean-onion (Tumbare and Pawar, 2003) [9] and okra-onion (Sharma *et al*., 2009) [8].

Table 1: Influence of fertility management treatments in maize - onion cropping system on dry matter yield, N, P, K and S concentration and uptake of onion leaf at 30 DAT

Fertilized(cumulative)	Dry matter ($q\ ha^{-1}$)	N		P		K		S	
		(%)	($kg\ ha^{-1}$)	(%)	($kg\ ha^{-1}$)	(%)	($kg\ ha^{-1}$)	(%)	($kg\ ha^{-1}$)
T_1: Control	2.30	1.03	2.41	0.16	0.37	2.12	4.87	0.31	0.72
T_2:50% N, P (RDF)	2.34	1.13	2.92	0.17	0.39	2.12	4.96	0.34	0.79
T_3:75% N, P (RDF)	2.58	1.24	5.23	0.17	0.43	2.12	5.48	0.34	0.87
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	4.22	1.27	5.50	0.17	0.71	2.15	9.07	0.34	1.43
T_5:75% N (RDF) + 25% N Poultry manure	4.33	1.34	5.86	0.18	0.77	2.22	9.60	0.38	1.62
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	4.35	1.36	5.98	0.18	0.78	2.23	9.70	0.38	1.65
T_7: 75% N (RDF) + 25% N Vermicompost	4.40	1.37	6.09	0.19	0.83	2.23	9.81	0.39	1.71
T_8: 75% N (RDF) + 25% N V.C. + AZB	4.45	1.36	5.93	0.20	0.91	2.24	9.96	0.39	1.73
T_9: 75% P (RDF)+ 25% P P.M.	4.34	1.35	5.85	0.18	0.78	2.23	9.67	0.38	1.65
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	4.34	1.35	5.86	0.19	0.82	2.23	9.67	0.38	1.64
T_{11}: 75% P (RDF) + 25% P V.C	4.34	1.35	5.86	0.19	0.82	2.23	9.67	0.38	1.64
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	4.34	1.36	5.90	0.21	0.91	2.24	9.73	0.39	1.69
Unfertlized(Residual)									
T_1: Control	1.88	1.01	1.89	0.11	0.20	2.11	3.96	0.25	0.47
T_2:50% N, P (RDF)	2.34	1.01	2.36	0.11	0.25	2.12	4.96	0.28	0.65
T_3:75% N, P (RDF)	2.34	1.01	2.36	0.11	0.25	2.12	4.96	0.30	0.70
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	3.21	1.01	2.38	0.11	0.26	2.12	5.00	0.31	0.73
T_5:75% N (RDF) + 25% N Poultry manure	3.21	1.04	3.33	0.12	0.38	2.21	7.10	0.35	1.12
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	3.21	1.04	3.33	0.12	0.38	2.21	7.10	0.36	1.15
T_7: 75% N (RDF) + 25% N Vermicompost	3.25	1.05	3.37	0.12	0.38	2.21	7.10	0.36	1.15
T_8: 75% N (RDF) + 25% N V.C. + AZB	3.23	1.05	3.41	0.13	0.42	2.23	7.24	0.36	1.16
T_9: 75% P (RDF)+ 25% P P.M.	3.23	1.05	3.39	0.12	0.38	2.21	7.13	0.35	1.13
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	3.23	1.05	3.39	0.13	0.42	2.21	7.13	0.36	1.16
T_{11}: 75% P (RDF) + 25% P V.C	3.23	1.05	3.39	0.12	0.38	2.21	7.13	0.35	1.13
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	3.23	1.05	3.39	0.13	0.42	2.22	7.17	0.36	1.16
Effect of kharif treatments at same levels of rabi treatments SEm±	0.07	0.04	0.20	0.01	0.02	0.06	0.24	0.01	0.03
CD(P=0.05)	0.20	0.12	0.58	0.03	0.06	NS	0.70	0.03	0.08
Effect of rabi treatments at same or different levels of kharif treatments SEm ±	0.50	0.29	1.35	0.02	0.14	0.41	1.50	0.07	0.24
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Influence of fertility management treatments in maize - onion cropping system on concentration and uptake of Fe, Mn,Zn and Cu in dry matter of onion leaf at 30 DAT

Fertilized(cumulative)	Fe		Mn		Zn		Cu	
	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})
T_1: Control	13.51	3.10	9.21	2.11	8.15	1.87	2.60	0.59
T_2:50% N, P (RDF)	13.53	3.16	9.23	2.15	8.15	1.90	2.60	0.60
T_3:75% N, P (RDF)	13.53	3.49	9.23	2.38	8.15	2.10	2.61	0.67
T_4:100% N, P through RDF(120-60 Kg N, P_2O_5 ha^{-1})	13.53	5.70	9.23	3.89	8.17	3.44	2.61	1.10
T_5:75% N (RDF) + 25% N Poultry manure	13.54	5.86	9.34	4.04	8.21	3.55	2.62	1.13
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	13.55	5.89	9.34	4.06	8.21	3.57	2.62	1.13
T_7: 75% N (RDF) + 25% N Vermicompost	13.55	5.96	9.34	4.10	8.22	3.61	2.62	1.15
T_8: 75% N (RDF) + 25% N V.C. + AZB	13.55	6.02	9.35	4.16	8.22	3.65	2.62	1.16
T_9: 75% P (RDF)+ 25% P P.M.	13.55	5.88	9.34	4.05	8.22	3.57	2.62	1.13
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	13.68	5.88	9.34	4.05	8.22	3.56	2.62	1.14
T_{11}: 75% P (RDF) + 25% P V.C	13.55	5.88	9.30	4.05	8.22	3.56	2.62	1.13
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	13.55	5.88	9.35	4.05	8.22	3.56	2.62	1.14
Unfertlized(Residual)								
T_1: Control	11.70	2.19	7.13	1.34	7.20	1.35	2.12	0.39
T_2:50% N, P (RDF)	11.72	2.74	7.14	1.67	7.21	1.68	2.15	0.50
T_3:75% N, P (RDF)	11.72	2.74	7.14	1.67	7.21	1.68	2.15	0.50
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	11.72	2.76	7.14	1.68	7.21	1.70	2.15	0.51
T_5:75% N (RDF) + 25% N Poultry manure	11.75	3.77	7.25	2.32	7.24	2.32	2.22	0.71
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	11.75	3.77	7.25	2.32	7.24	2.32	2.22	0.71
T_7: 75% N (RDF) + 25% N Vermicompost	11.75	3.77	7.25	2.32	7.24	2.32	2.22	0.71
T_8: 75% N (RDF) + 25% N V.C. + AZB	11.76	3.82	7.25	2.35	7.25	2.35	2.23	0.72
T_9: 75% P (RDF)+ 25% P P.M.	11.75	3.79	7.25	2.34	7.24	2.33	2.23	0.72
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	11.75	3.79	7.25	2.34	7.24	2.33	2.23	0.72
T_{11}: 75% P (RDF) + 25% P V.C	11.75	3.80	7.25	2.34	7.24	2.33	2.22	0.71
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	11.76	3.80	7.25	2.34	7.25	2.34	2.23	0.72
Effect of kharif treatments at same levels of rabi treatments SEm±	0.10	0.02	0.06	0.03	0.05	0.03	0.04	0.01
CD(P=0.05)	NS	0.58	NS	0.09	NS	0.09	NS	0.03
Effect of rabi treatments at same or different levels of kharif treatments SEm±	0.70	0.15	0.23	0.11	0.39	0.09	0.28	0.09
CD(P=0.05)	NS	0.43	NS	0.32	NS	0.26	NS	NS

Cumulative and Residual effect on on dry matter (q ha^{-1}), concentration of N, P, K, S, Fe, Mn, Zn and Cu and their uptake (kg ha^{-1}) by onion bulb at 30 days after transplanting

The data on dry matter accumulation in onion bulbs concentration of N, P, K and S and their uptake recorded at 30 days after transplanting of onion with different fertility treatments is presented in table 3. The mean dry matter production in onion bulbs owing to the combined influence of different nutrient management treatments to maize in *kharif* and fertilizer application to onion in *rabi* recorded a significant change. The cumulative influence of inorganic fertilizers with the recommended level of N and P to maize and 75% recommended dose of N, P and K to onion significantly increased the dry matter compared to the direct effect of fertilizer application only to onion. The bulbs recorded 1.74 q ha^{-1} drymatter due to the direct influence of fertilizer application. The cumulative influence due to the residual effect of fertilizer application to preceding maize and direct effect of fertilizer application to onion significantly increased the drymatter to 1.78 q ha^{-1}.These trends were also reflected in the mean dry matter production of onion due to the residual effects of fertility management treatments in maize on the succeeding untreated onion, the latter accumulated 1.26 q ha^{-1} dry matter in the bulbs due to the residual influence of inorganic fertilizer application to the preceding maize. Significantly less quantity of 0.96 q ha^{-1} dry matter was recorded without the application of fertilizers to both the crops. The residual effect due to the integrated supply of nutrients to maize further enhanced the dry matter compared to the inorganic fertilizer application to maize.

The increase in dry matter due to any integrated nutrient management treatment to maize and fertilizer application to onion was significantly superior compared to the increase due to residual effect of integrated nutrient management treatments on unfertilized onion over the residual effect of fertilizer alone. The dry matter of 1.78 q ha^{-1} due to the cumulative influence of inorganic fertilization to maize- onion cropping system increased to 2.23 q ha^{-1} in response to the substitution of 25% N through poultry manure to maize. The magnitude of this enhancement was larger than the critical value ranging 1.26 to 1.29 q ha^{-1} for the same set of treatments applied to maize and no fertilizer application to onion. Similarly, these trends were consistent, indicating the synergistic effect of integrated nutrient management than inorganic fertilization to maize in enhancing the dry matter of fertilized than the unfertilized onion.

The nutrient content in the bulbs of onion recorded substantial variation due to different fertility management treatments. The concentration of N increased significantly due to the cumulative influence of different levels of N and P fertilizers to maize and fertilizer application to onion compared to the direct effect of fertilizing only the onion crop. But, the residual effect of different levels of fertilizer application to maize did not influence the concentration of N in onion bulbs grown after the unfertilized maize. The increase in concentration of N due to the cumulative influence of integrated nutrient management to maize and fertilizer application to onion over the cumulative influence due to fertilizer application to both the crops was of similar magnitude as with the increase due to the residual effect of integrated nutrient management over treated maize. The concentration of P, K and S was more on fertilizer application to onion. The bulbs had 0.20% P as a result of direct effect of fertilizer application. There was no appreciable change due to the cumulative influence of inorganic fertilizer application to both the crops or due to the integrated nutrient management treatments to maize and fertilizer application to onion. The

substitution of 25% P with vermicompost and addition of phosphorus solubilising bacteria in *kharif* to maize followed by fertilizer application to onion significantly increased the concentration of P in onion by 0.22%. The untreated onion recorded significant concentration of P due to the residual effect accruing through integrated nutrient management by substituting 25% P either with poultry manure or vermicompost with or without the addition of phosphorus solubulising bacteria. The response due to the integrated nutrient management over fertilizer application was similar both due to cumulative and residual effects.

The fertilizer treated onion had a concentration of 2% K. It increased significantly to 2.16% due to the cumulative effect of fertilizer application to both the crops. The cumulative effect of integrated nutrient supply treatments to maize and fertilizer application to onion was on par with the inorganic fertilizer application to both the crops. The residual effect of fertilizer application to maize did not influence the concentration of K in the bulbs of onion not treated with fertilizer. The residual effect due to the integrated nutrient management treatments was on par with the residual effect of fertilizer application to maize. The response trends of the integrated nutrient management treatments compared to fertilizer application were similar in effect on K concentration both due to cumulative and residual fertility.

Onion accumulated 0.34% S in the bulbs due to the direct effect of fertilizer application. It did not change due to the cumulative influence of different levels of fertilizer application to maize and the application of 75% recommended levels of N, P, K to onion. The integrated supply of nutrients to maize and fertilizer application to onion significantly increased the concentration of this nutrient compared to the inorganic fertilizer application to both the crops. The untreated onion had a concentration of 0.22% S. The residual effect of recommended level of N and P fertilizers to maize significantly increased the S concentration to 0.26%. The residual effect due to substitution of 25% N or P with organic manures did not alter the S content remarkably compared to inorganic fertilizer application. The response trends due to the integrated nutrient management treatments and fertilizer application to maize were similar with respect to concentration of S in the bulbs of onion grown with or without the application of fertilizers.

The N, P, K and S uptake of treated onion was more than the untreated crop. The uptake of these nutrients was 2.19, 0.34, 3.47 and 0.59 kg ha^{-1} due to the direct influence of fertilizer application to onion. There was a significant increase in the uptake of these nutrients to 2.33, 0.37, 3.84 and 0.60 kg ha^{-1} due to the cumulative influence of fertilizer application to maize and onion. The cumulative effect due to integrated nutrient management treatments to maize and fertilizer application to onion significantly increased the uptake of these four nutrients than due to the fertilizer application. The untreated onion exhibited larger uptake of these nutrients due to the residual effect of fertilizer application as well as integrated nutrient management treatments to maize. The uptake was 0.97 kg ha^{-1} N, 0.15 kg ha^{-1} P, 1.90 kg ha^{-1} K and 0.21 kg ha^{-1} S by growing onion without fertilizer application. The residual effect due to the integrated nutrient management treatments by substituting 25% P with vermicompost with or without the addition of phosphorus solubilising bacteria increased the uptake of these nutrients over the residual influence due to inorganic fertilizer application.

The response trend in the uptake of N, P and K due to the cumulative and residual effects of integrated versus inorganic fertilizers were similar. But the increase in uptake of S was much higher due to the cumulative than the residual influence of integrated nutrient management treatments over fertilizer application to maize.

The data on concentration and uptake of micronutrients in response to the direct, cumulative and residual fertility levels is presented in table 4. The results showed that the concentration of Fe, Mn, Zn and Cu was more in the bulbs of onion treated with 75% recommended level of N, P, K. There was no significant difference in the concentration of these micronutrients due to this direct effect of fertilizer application to onion compared to the cumulative influence by fertilizing both the crops. The cumulative effect of substitution of 25% N or P fertilizers with organic manures to maize significantly increased the concentration of Zn and Cu compared to the inorganic fertilization. The concentration of Fe, Mn, Zn and Cu was not influenced by the residual effect of fertilizers. But, these micronutrients increased significantly in the untreated onion crop due to the residual effect of integrated nutrient management treatments in maize. The responses due to the cumulative and residual influence of integrated nutrient management treatments were similar both in the untreated and treated onion.

Onion removed 1.25 g ha^{-1} Fe, 1.07 g ha^{-1} Mn and 0.39 g ha^{-1} Cu due to the direct influence of fertilizer application. The cumulative effect of fertilizer application to maize and onion significantly increased the uptake of these nutrients to 1.28, 1.10 and 0.40 g ha^{-1} respectively. But, the uptake of Zn alone was on par due to the cumulative and direct effect of fertilizer application. The cumulative effect due to integrated nutrient management treatments by substituting 25% N or P with poultry manure or vermicompost significantly increased the uptake of these micronutrients compared to the inorganic fertilizer application to both the crops. The uptake of Fe, Mn, Zn and Cu was substantially low in the unfertilized onion irrespective of the nutrient management treatments to preceding maize. The unfertilized onion removed 0.59 g ha^{-1} Fe, 0.50 g ha^{-1} Mn, 0.30 g ha^{-1} Zn and 0.20 Cu at 30 days after transplanting. The uptake of the corresponding micronutrients increased significantly to 0.78, 0.65, 0.40 and 0.26 g ha^{-1} due to the residual influence of recommended level of N and P fertilizers applied to preceding maize crop. The residual effect of integrated nutrient management treatments to maize was more beneficial. The uptake of these micro nutrients increased further. The response to the integrated nutrient management treatments over fertilizer application was significantly superior through their cumulative than their residual influence.

Conclusion

The nutritional quality of young onion plants (Leaves and bulb) is very important in human diet, as they are very much consumed as salad and curry form. Superior nutritional quality and dry matter production is recorded in cumulative strips than the direct and residual influence. Among the nutrient treatments of preceding maize integrated treatments gave high dry matter and nutritional quality in vegetable onion.

Table 3: Influence of fertility management treatments in maize - onion cropping system on dry matter (q ha^{-1}), N, P, K and S content(%) and their uptake in onion bulb (kg ha^{-1}) at 30 DAT.

Fertilized (cumulative)	Dry matter (q ha^{-1})	N		P		K		S	
		(%)	(kg ha^{-1})	(%)	(kg ha^{-1})	(%)	(kg ha^{-1})	(%)	(kg ha^{-1})
T_1: Control	1.74	1.26	2.19	0.20	0.34	2.00	3.47	0.34	0.59
T_2:50% N, P (RDF)	1.78	1.30	2.28	0.20	0.35	2.00	3.52	0.34	0.59
T_3:75% N, P (RDF)	1.76	1.31	2.30	0.20	0.35	2.15	3.78	0.34	0.59
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	1.78	1.31	2.33	0.21	0.37	2.16	3.84	0.34	0.60
T_5:75% N (RDF) + 25% N Poultry manure	2.23	1.32	2.94	0.21	0.46	2.20	4.91	0.38	0.84
T_6: 75% N (RDF) + 25% N Poultry manure + Azotobacter	2.23	1.34	2.98	0.21	0.46	2.22	4.95	0.38	0.84
T_7: 75% N (RDF) + 25% N Vermicompost	2.25	1.34	3.01	0.21	0.47	2.24	5.03	0.39	0.87
T_8: 75% N (RDF) + 25% N V.C. + Azotobacter	2.26	1.35	3.05	0.21	0.47	2.26	5.10	0.39	0.88
T_9: 75% P (RDF)+ 25% P P.M.	2.25	1.34	3.01	0.21	0.47	2.24	5.04	0.38	0.85
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	2.25	1.34	3.01	0.22	0.49	2.25	5.06	0.38	0.85
T_{11}: 75% P (RDF) + 25% P V.C	2.24	1.34	3.00	0.21	0.47	2.25	5.03	0.38	0.85
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	2.25	1.34	3.01	0.22	0.49	2.25	5.06	0.39	0.87
Unfertilized (Residual)									
T_1: Control	0.96	1.02	0.97	0.16	0.15	1.98	1.90	0.22	0.21
T_2:50% N, P (RDF)	0.96	1.03	0.98	0.17	0.16	1.98	1.90	0.22	0.21
T_3:75% N, P (RDF)	0.98	1.04	1.01	0.17	0.16	2.12	2.07	0.22	0.22
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	1.26	1.04	1.31	0.17	0.21	2.12	2.66	0.26	0.33
T_5:75% N (RDF) + 25% N Poultry manure	1.29	1.05	1.35	0.18	0.23	2.15	2.77	0.26	0.33
T_6: 75% N (RDF) + 25% N Poultry manure + Azotobacter	1.30	1.06	1.37	0.18	0.23	2.15	2.79	0.28	0.36
T_7: 75% N (RDF) + 25% N Vermicompost	1.33	1.07	1.42	0.18	0.23	2.16	2.87	0.28	0.37
T_8: 75% N (RDF) + 25% N V.C. + Azotobacter	1.34	1.09	1.46	0.18	0.24	2.17	2.90	0.29	0.39
T_9: 75% P (RDF)+ 25% P P.M.	1.32	1.05	1.38	0.19	0.25	2.16	2.85	0.28	0.36
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	1.33	1.06	1.40	0.19	0.25	2.16	2.87	0.31	0.41
T_{11}: 75% P (RDF) + 25% P V.C	1.32	1.07	1.41	0.19	0.25	2.16	2.85	0.29	0.38
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	1.33	1.09	1.45	0.19	0.25	2.16	2.95	0.29	0.38
Effect of kharif treatments at same levels of rabi treatments SEm±	0.01	0.01	0.02	0.004	0.01	0.05	0.09	0.01	0.01
CD(P=0.05)	0.03	0.04	0.06	0.012	0.02	0.15	0.26	0.03	0.04
Effect of rabi treatments at same or different levels of kharif treatments SEm±	0.07	0.09	0.14	0.029	0.03	0.24	0.44	0.04	0.05
CD(P=0.05)	0.20	NS	0.41	NS	NS	NS	NS	NS	0.14

Table 4: Influence of fertility management treatments in maize - onion cropping system on concentration and uptake of Fe, Mn, Zn and Cu in dry matter of onion bulb at 30 DAT.

Fertilized (cumulative)	Fe		Mn		Zn		Cu	
	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})	(mg kg^{-1})	(g ha^{-1})
T_1: Control	7.21	1.25	6.20	1.07	4.10	0.71	2.25	0.39
T_2:50% N, P (RDF)	7.21	1.26	6.21	1.09	4.10	0.72	2.25	0.39
T_3:75% N, P (RDF)	7.22	1.27	6.21	1.09	4.15	0.73	2.26	0.39
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	7.22	1.28	6.22	1.10	4.15	0.73	2.26	0.40
T_5:75% N (RDF) + 25% N Poultry manure	7.24	1.61	6.22	1.38	4.21	0.93	2.36	0.52
T_6: 75% N (RDF) + 25% N Poultry manure + Azotobacter	7.24	1.61	6.23	1.39	4.21	0.93	2.36	0.52
T_7: 75% N (RDF) + 25% N Vermicompost	7.25	1.63	6.24	1.40	4.23	0.95	2.37	0.53
T_8: 75% N (RDF) + 25% N V.C. + AZB	7.25	1.63	6.24	1.41	4.23	0.95	2.37	0.53
T_9: 75% P (RDF)+ 25% P P.M.	7.25	1.63	6.24	1.40	4.21	0.94	2.36	0.53
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	7.26	1.63	6.24	1.40	4.21	0.94	2.36	0.53
T_{11}: 75% P (RDF) + 25% P V.C	7.24	1.62	6.24	1.39	4.21	0.94	2.36	0.52
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	7.25	1.63	6.24	1.40	4.23	0.95	2.36	0.53
Unfertilized (Residual)								
T_1: Control	6.20	0.59	5.21	0.50	3.19	0.30	2.10	0.20
T_2:50% N, P (RDF)	6.20	0.59	5.21	0.50	3.19	0.30	2.10	0.20
T_3:75% N, P (RDF)	6.20	0.60	5.21	0.51	3.19	0.31	2.10	0.20
T_4:100% N, P through RDF (120-60 Kg N, P_2O_5 ha^{-1})	6.21	0.78	5.21	0.65	3.20	0.40	2.11	0.26
T_5:75% N (RDF) + 25% N Poultry manure	6.42	0.82	5.34	0.68	3.28	0.42	2.22	0.28
T_6: 75% N (RDF) + 25% N Poultry manure + azotobacter	6.42	0.83	5.34	0.69	3.28	0.42	2.22	0.28
T_7: 75% N (RDF) + 25% N Vermicompost	6.43	0.85	5.35	0.71	3.30	0.43	2.22	0.29
T_8: 75% N (RDF) + 25% N V.C. + AZB	6.43	0.86	5.34	0.71	3.30	0.44	2.23	0.29
T_9: 75% P (RDF)+ 25% P P.M.	6.43	0.84	5.34	0.70	3.28	0.43	2.22	0.29
T_{10}: 75% P (RDF) + 25% P P.M. + Phosphorus solubilising bacteria	6.43	0.85	5.34	0.71	3.28	0.43	2.22	0.29
T_{11}: 75% P (RDF) + 25% P V.C	6.43	0.84	5.34	0.70	3.28	0.43	2.22	0.29
T_{12}: 75% P RDF + 25% P V.C + P.S.B.	6.43	0.85	5.34	0.71	3.30	0.44	2.22	0.29
Effect of kharif treatments at same levels of rabi treatments SEm±	0.01	0.01	0.04	0.01	0.02	0.01	0.01	0.00
CD(P=0.05)	0.03	0.03	0.13	0.03	0.06	0.03	0.03	0.01
Effect of rabi treatments at same or different levels of kharif treatments SEm±	0.09	0.04	0.29	0.03	0.14	0.03	0.12	0.02
CD(P=0.05)	NS	0.12	NS	0.08	NS	0.08	NS	0.04

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