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EFFECTS OF INTEGRATED NUTRIENT MANAGEMENT UPTAKE ON SEED YIELD OF ONION

M. N. YOUSUF[1], S. BRAHMA[2], M. A. A. KHAN[3]
M. M. A. SARKER[4] AND S. K. DATTA[5]

Abstract

The field experiment was conducted during two successive *rabi* seasons of 2015-16 and 2016-17 in the research field of BARI, Gazipur, to evalute the effect of integrated nutrient management (INM) on seed yield and nutrient uptake of onion (var. BARI Piaz-1). The experiment was arranged in Randomized Complete Block Design (RCBD) with three replications having eight nutrient management packages following the INM principle. There were significant effects of INM on the seed yield, yield contributing characters and nutrient uptake of onion. The highest seed yield of 1278 and 1287 kg ha^{-1} was obtained from treatment poultry liter (PL) based trichocompost (TC) @ 3t ha^{-1} + chemical fertilizers (IPNS basis) and the minimum seed yield (395 kg ha^{-1} and 441 kg ha^{-1}) in control (native fertility) treatment in 2015-2016 and 2016-2017, respectively. The N uptake by onion crop ranged from 37.1 to 141.5 kg ha^{-1} and 42.1 to 146.7 kg ha^{-1}, P uptake from 2.9 to 13.5 kg ha^{-1} and 3.8 to 20.2 kg ha^{-1}, K uptake from 24.5 to 76.7 kg ha^{-1} and 30.7 to 74.3 kg ha^{-1} and the S uptake ranged from 5.8 to 14.5 kg ha^{-1} and 6.1 to 18.8 kg ha^{-1} in two respective years. Hence, the PL based TC @ 3 t ha^{-1} + CF (IPNS) could be regarded as the best nutrient management package for achieving higher onion seed production in Grey Terrace Soil of Madhupur Tract (AEZ-28).

Keywords: Onion, INM, Nutrient uptake, Seed yield.

Introduction

Onion (*Allium cepa* L.) is a spice crop which belongs to the family Alliaceae. Its leaves, bulbs and inflorances are all used as spices and vegetables for its medicinal and seasoning properties (Kumar *et al*., 2018). Bangladesh is the world's third largest onion producing country having production potential of, 19.54 lakh Metric tons bulbs in 1.85 lakh hectares of land (BBS, 2021). The annual production of onion seed in Bangladesh is about 700 metric tons per year, whereas the requirement is more than 1100 metric tons per year (Anon., 2020). It is reported that quality seed can ensure 15-20% higher yield (Huda and Ali, 2013). Seed production of onion is a tedious job, which require a special technique due to its biannual nature, the first *rabi* season for bulb production and

[1&2]Senior Scientific Officer, [3]Scientific Officer, Regional Spices Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur, [4]Deputy Director, Bangladesh Water Development Board, Dhaka and [5]Upazila Agriculture Officer, Moulvibazar Sadar, Bangladesh.

the next *rabi* season for bulb replanting for seed production. Among the yield limiting factors, nutrient management plays a key role for quality seed production of crops (Singh *et al.*, 2017). Combined application of organic and inorganic fertilizers is a sustainable nutrient management technology for better crop production. Application of organic materials such as compost, green manures, cow dung, farmyard manures and bio-fertilizers not only improves soil health but it also helps nutrient uptake from soil to plant (Kamal and Yousuf, 2012, Shaheen *et al.*, 2007). Integrated nutrient management, which entails the maintenance or adjustment of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients: organics as well as inorganics in an integrated approach (Khatun *et al*., 2016, Patil *et al.*, 2007). Integrated plant nutrient management improves soil properties, enhances nutrient use efficiency of crops and also maintains equilibrium of environment (Bagali *et al*., 2012 and Dilshad, 2010). Imbalance application of fertilizers cause yield reduction of onion and may lead to degrade soil quality. Hence, the present study was planned: (i) to identify the best integrated nutrient management packages for onion seed production and (ii) to see soil nutrient balances against different nutrient management packages.

Materials and Methods

The field experiment was conducted in the research field of Irrigation and Water management (IWM) Division of Bangladesh Agricultural Research Institute (BARI), Gazipur ($23^0 59^/$ North Latitude, $90^0 24^/$ East Longitude and 8.4 m elevation) during, two successive *rabi* seasons of 2015-16 and 2016-17. The soil of the experimental site belongs to Chhiata Soil series and has been classified as Grey Terrace Soil, which falls under Inceptisol in Soil Taxonomy under the AEZ-28 (Madhupur Tract). Basic soil properties of the experimental field are presented in Table 1. The experiment was laid out in a Randomized Complete Block Design (RCBD) with eight treatments and three replications. The treatments were: T_1 = RDCF (115-55-75-20-1.5-1 kg NPKSZnB ha^{-1}); T_2 = CD @ 5 t ha^{-1} + CF (IPNS); T_3 = PL @ 3 t ha^{-1} + CF (IPNS); T_4 = CD based VC @ 5 t ha^{-1} + CF (IPNS); T_5 = PL based VC @ 3 t ha^{-1} + CF (IPNS); T_6 = CD based TC @ 5 t ha^{-1} + CF(IPNS); T_7 = PL based TC @ 3 t ha^{-1} + CF (IPNS) and T_8 = absolute control. The total amount of cowdung (CD), poultry liter (PL), vermicompost (VC), trichocompost (TC), TSP for P, ½ of MoP for K, gypsum for S, $ZnSO_4$ for Zn and Solobor for B were applied during final land preparation. Urea as a source of N was applied in 3 equal splits at 30, 45 and 60 days after planting (DAP) and the rest half of MoP was applied at 45 DAP. The chemical compositions of applied organic manures are presented in Table 2. The unit plot size was 4 m x 1.5 m. The similar sized bulbs were planted on 10 November 2015 and 12 November 2016, respectively, with a spacing of 20 cm x 15 cm. Bulbs were treated with Autostin (carbendazim) @ 2 g kg^{-1} to reduce the

primary seed borne disease. The essential intercultural operations (three hand weedings, six light irrigations and spraying of Robral @ 2 g l^{-1} + Ridomil Gold @ 2 g l^{-1} in every 10 days interval for controlling purple blotch disease and Admire @ 2 m l^{-1} for management of *Thrips*) were done throughout the cropping season. All the umbels did not mature simultaneously, when about 20-30% of the capsules of the umbel turned to green to straw color, then the umbels were cut at 5-7 cm below the umbel attachment. Umbels were harvested on 22-23 March 2016 and 19-22 March 2017, respectively. Umbels were dried in sunlight, when the umbels were completely dried these were threshed and seeds were collected after cleaning. Ten randomly pre-selected plants from each treatment were used for recording data. The recorded data on different parameters were subjected to statistical analysis using *R* version 3.5.0 to find out the significant of variation of the treatments. Mean separation was done by DMRT at 5% level of significance.

Table 1. Soil properties of the experimental field

Soil Properties	Analytical value		Analytical method
	2015-16	2016-17	
Soil texture	Silty clay loam	Silty clay loam	Hydrometer method
Soil pH	6.0	6.1	Soil: water=1:2.5
Organic carbon (%)	0.83	0.83	Wet oxidation method
Available N (%)	0.0091	0.009	Alkaline permanganate Method
Available P (ppm)	6.6	6.7	Bray and Kurtz method
Exchangeable K (meq 100 g^{-1} soil)	0.10	0.10	N NH_4OAc extraction method
Exchangeable Ca (meq 100 g^{-1} soil)	1.34	1.32	N NH_4OAc extraction method
Exchangeable Mg (meq 100 g^{-1} soil)	0.45	0.43	N NH_4OAc extraction method
Exchangeable Na (meq/100g)	0.30	0.31	N NH_4OAc extraction method
CEC (meq 100 g^{-1} soil)	9.25	9.20	N NH_4OAc extraction method
Available B (ppm)	0.18	0.18	Calcium chloride extraction method
Available Zn (ppm)	0.45	0.47	DTPA Extraction method
Available Cu (ppm)	0.17	0.18	DTPA Extraction method
Available Mn (ppm)	0.78	0.77	DTPA Extraction method
Available S (ppm)	7.9	8.1	Calcium dihydrogen phosphate extraction method

Table 2. Nutrient status of organic manure used in the experiment

Organic manure	pH	OC	N	K	P	S
		(%)				
Cowdung (CD)	7.4	11.5	0.6	0.5	0.6	0.05
Poultry liter (PL)	7.9	17.4	1.6	0.4	1.5	0.03
CD based vermicompost (VC)	7.5	13.2	1.9	0.8	2.0	0.02
PL based VC	7.4	19.5	1.9	0.9	2.1	0.02
CD based tricocompost (TC)	7.0	13.5	1.6	1.1	0.9	0.03
PL based TC	7.3	15.7	1.3	0.9	1.1	0.03

For computing nutrient uptake at 115 DAS plants in every plot were cut at the bottom, chopped with a sharp knife, air dried for 3 days then oven dried for 72 hours at 65^0C followed by grinding the oven-dry samples by an electric grinding machine.

Nutrient uptake from the soil was calculated by using the formula:

Nutrient uptake = % A x Y / 100 kg ha^{-1}

Where,

% A = Nutrient content of plant in percent; Y = Total dry matter production of plant (kg ha^{-1})

Results and Discussion

Vegetative growth components of onion were significantly influenced by different IPNS based nutrient management treatments in 2015-16 and 2016-17 (Table 3). The tallest plant (91.1 cm & 92.3 cm), maximum days to bolting (67.9 and 69), days to flowering (82.3 and 86.7), maximum number of umbels per plant (6.5 and 6.2) and the largest flower stalk diameter (1.21 cm and 1.22 cm) were recorded from treatment PL based TC @ 3 t ha^{-1} + CF (IPNS) during 2015-16 and 2016-17, respectively). The shortest plant (65.3 cm and 70 cm), minimum days to bolting (56.7 and 58.7), minimum days to flowering (66 and 68.7), minimum number of umbels per plant (4.4 and 4.3) and minimum flower stalk diameter (0.72 cm and 0.78 cm) were noted from absolute control treatment in both the years. Plant nutrients accelerate vegetative growth of onion plants by enhancing physiological and metabolic activities (Asgele *et al.*, 2018).

Table 3. Vegetative growth parameters of onion under varying integrated nutrient management

Treatment	Plant height (cm)		Days to bolting		Days to 50% flowering		Flower stalk diameter (cm)		No. of umbels per plant	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	85.0d	86b	61.7d	64d	74.3cd	79.3b	0.89f	0.95c	5.6a	5.7ab
T_2	87.8b	88.7ab	62.7cd	65.3cd	74d	82ab	1.03e	1.10b	5.7a	5.3b
T_3	89.7a	90.7ab	63cd	66bcd	78.3b	84ab	1.11cd	1.18a	6.2a	5.3b
T_4	87.7b	90ab	64c	67abc	78b	85.7ab	1.08d	1.18a	6.1a	6a
T_5	85.6cd	89.3ab	66b	68ab	77.7bc	85.3ab	1.15b	1.17ab	6.3a	6a
T_6	86.7bc	90.3ab	67.7ab	69a	77.7bc	86a	1.14bc	1.19a	6.4a	6a
T_7	91.1a	92.3a	67.9a	69a	82.3a	86.7a	1.21a	1.22a	6.5a	6.2a
T_8	65.3e	70c	56.7e	58.7e	66e	68.7c	0.72g	0.78d	4.4b	4.3c
CV (%)	0.10	3.18	1.38	2.49	2.56	4.54	2.15	4.0	10.22	6.0

In a column, means showing uncommon letters are significantly different at p≤0.5 by DMRT.

Table 4. Reproductive growth parameters of onion under varying integrated nutrient management

Treatment	No. of effective florets per umbel		Umbel diameter (cm)		No. of seeds per umbel		1000 -seed weight (g)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	294g	311.3d	4.99g	4.93e	586d	567c	2.97e	3.07c
T_2	308f	325cd	5.19f	5.78d	604c	580bc	3.25cd	3.09c
T_3	312e	335.3bcd	5.83e	6.0cd	607.7c	591abc	3.03e	3.15bc
T_4	323d	345.3abc	5.89d	6.08bcd	609.3bc	606abc	3.32bc	3.16abc
T_5	328c	353.3abc	5.97c	6.29abc	630.7ab	614abc	3.35b	3.21abc
T_6	339b	362ab	6.07b	6.36ab	646.3a	624ab	3.19d	3.25ab
T_7	355a	371.7a	6.13a	6.45a	663.7a	642a	3.47a	3.41a
T_8	208h	214.7e	3.17h	3.69f	322.3e	348d	2.86f	3.14bc
CV (%)	0.31	5.39	0.40	5.69	1.58	5.28	1.69	2.83

In a column, means showing uncommon letters are significantly different at p≤0.5 by DMRT.

IPNS based fertilizer treatments had positive effect on reproductive growth parameters of onion (Table 4). The highest number of effective florets per umbel (355 and 371.7), biggest umbel (6.13 cm and 6.45 cm) and maximum number of seeds per umbel (663.7 and 642) were recorded from the treatment PL based TC @ 3 t ha^{-1} + CF (IPNS) during 2015-16 and 2016-17, respectively. The minimum number of effective florets per umbel (208 and 214.7) was noted in control treatment. The applied nutrients might have influenced adequate growth and seed development,

thereby favoring the maximum seed yield. The maximum weight of 1000-seed (3.47 g and 3.41 g) was found from PL based TC @ 3 t ha^{-1} + CF (IPNS) and the lowest (2.86 g & 3.14 g) noted from control in both years. It is assumed that the IPNS based nutrient management supplied sufficient macro & micro nutrients, which favoured growth promoting and enzymatic activities of plants.

Both seed yield and biomass yield of onion varied significantly due to different IPNS based nutrient management treatments during 2015-16 and 2016-17 (Table 5). The highest seed yield per hectare (1278 kg and 1287 kg) was obtained from treatment PL based TC @ 3 t ha^{-1} + CF (IPNS) and the minimum value (395 kg and 441 kg) being recorded from control treatment in 2015-16 and 2016-17, respectively. Thus, it is apparent that the macro and micronutrients needed for higher seed yield of onion. This was supplied by organic manure used in IPNS based nutrient management system. Similar results were stated by Yousuf *et. al.* (2013) and Patil *et al.* (2007). The maximum biomass yield (4619 and 4730 kg ha^{-1} in 2015-16 and 2016-17, respectively) was recorded from T_7 treatment: PL based TC @ 3 t ha^{-1} + CF (IPNS). The minimum biomass yield (1952 and 1907 kg ha^{-1}) was noted from T_8 treatment (absolute control) in both the years. Biomass production depends on the synthesis, accumulation and translocation of photosynthates depend upon efficient photosynthetic structure as well as source sink relationship. The biomass yield is mostly controlled by nutrient mobility and translocation of photosynthates by plant. Similar results are depicted by Yousuf (2018) and Shafeek *et al.* (2013). The highest germination of onion (94.3 and 93% in two years, respectively) has been noticed in PL based TC @ 3t ha^{-1} +CF (IPNS) and lowest (77.3% and 81%) in control (Table 5). This may be due to IPNS based nutrient management, providing sufficient nutrition's for crop growth and development.

Table 5. Effect of different integrated nutrient management on the seed yield, biomass yield and seed germination of onion

Treatment	Seed yield (kg ha^{-1})		Biomass yield (kg ha^{-1})		Germination (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	1026.89e	1116.83d	4321.7d	4370.3e	85.3c	89c
T_2	1178.4d	1195.8c	4513.3c	4558.7cd	91.3ab	91abc
T_3	1199.55cd	1217.97bc	4512.3bc	4525d	89.3b	90.7bc
T_4	1215.92bc	1244.26ab	4536.3abc	4587cd	85.7c	90.7bc
T_5	1217.55bc	1252.71ab	4572.7abc	4618.7bc	91.3ab	92ab
T_6	1243.97ab	1272.15a	4603ab	4682ab	92.3ab	92ab
T_7	1277.53a	1287.38a	4618.7a	4730.3a	94.3a	93a
T_8	394.77f	441.06e	1951.7f	1906.7f	77.3d	81d
CV (%)	1.81	2.38	0.96	0.96	2.08	1.37

In a column, means showing uncommon letters are significantly different at $p \leq 0.5$ by DMRT.

Nutrient uptake

IPNS based nutrient management had favoured the uptake of N, P, K and S by onion (Table 6). The N uptake by onion crop ranged from 37.1 to 141.5 kg ha^{-1} and 42.1 to 146.7 kg ha^{-1}, P uptake ranged from 2.9 to 13.5 kg ha^{-1} and 3.8 to 20.2 kg ha^{-1}, K uptake ranged from 24.5 to 76.7 kg ha^{-1} and 30.7 to 74.3 kg ha^{-1} and S uptake ranged from 5.8 to 14.5 kg ha^{-1} and 6.1 to 18.8 kg ha^{-1} in 2015-16 and 2016-17, respectively, under different nutrient managements. The maximum uptake of N, P, K and S (141.5 and 146.7, 13.5 and 20.2, 76.7 and 74.3 and 14.5 and 18.8 kg ha^{-1}) was recorded in T_7 treatment: PL based TC @ 3 t ha^{-1} + CF (IPNS) followed by T_6: CD based TC @ 5 t ha^{-1} + CF (IPNS). The minimum uptake of N, P, K and S (37.1 and 42.1, 2.9 and 3.8, 24.5 and 30.7 and 5.8 and 6.1 kg ha^{-1}) were noted in T_8 (absolute control) treatment in 2015-16 and 2016-17, respectively. These results are in agreement with the research findings of Nasreen *et al*. (2007), Shafeek *et al.* (2013) and Kumar *et al.* (2018).

Table 6. Effect of different nutrient managements on N, P, K and S uptake by onion crop

Treatment	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		S uptake (kg ha^{-1})	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	95.5f	106.7e	6.9g	12.3d	61.2d	56.3d	9.7g	10.1d
T_2	123e	120.4d	11.6f	14.5cd	67.3c	62.3c	11.1f	11.9cd
T_3	128.1d	127.2cd	11.8e	16.6bc	70.3bc	63.7bc	11.6e	13.1c
T_4	129.8d	129.8d	12.7d	17.6abc	71.7abc	63.7bc	12.9d	13.9c
T_5	135.4c	137.7b	12.8c	18.9ab	73.7ab	70.3ab	13.7c	14.3bc
T_6	140.4b	143.3ab	12.9b	19.7ab	76.7a	72a	13.9b	17ab
T_7	141.5a	146.7a	13.5a	20.2a	76.7a	74.3a	14.5a	18.8a
T_8	37.1g	42.1f	2.9h	3.8e	24.5e	30.7e	5.8h	6.1e
CV (%)	1.62	3.74	1.62	13.1	4.76	5.47	1.30	13.03

In a column, means showing uncommon letters are significantly different at $p \leq 0.5$ by DMRT.

Conclusion

Application of organic manure with integration of chemical fertilizer significantly influenced seed yield and nutrient uptake of onion. The highest seed yield of 1278 and 1287 kg ha^{-1} in 2015-16 and 2016-17, respectively was obtained from poultry liter (PL) based trichocompost (TC) @ 3 t ha^{-1} + chemical fertilizers (IPNS basis). The uptake of N, P, K and S by the crop was also highly favoured by the integrated use of chemical fertilizers and organic manure. The

overall results indicate that the PL based TC @ 3t ha^{-1} + CF (IPNS) appears to be the best management package for achieving higher seed yield of onion in Grey Terrace Soil of Madhupur Tract (AEZ-28).

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