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Short Communication

Studies on integrated nutrient management on yield contributing characters and soil nutrient status in onion (*Allium cepa* l.)

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Onion (*Allium cepa* L.) is one of the oldest vegetable found in a large number of recipes and preparations spanning almost the totality of the world's culture. It has occupied an important place in Indian diet being consumed throughout the year by almost all classes of people. It adds flavor to various vegetable preparations, hence it is called as queen of kitchen. As the availability of land is decreasing day by day, application of chemical fertilizers has become necessary to meet the demand for food grains. So to sustain soil health and benign environment, balanced application of organic and inorganic fertilizers is essential. Much research has been conducted on the use of inorganic fertilizers in onion to increase the production and productivity of the crop. Onion is important bulbous vegetable crops widely grown in Maharashtra. There is need to standardize the optimum organic and inorganic nutrients along with bio-fertilizers to such a important crop in Western Maharashtra for sustaining the soil health. The integrated use of organic and inorganic fertilizers along with bio-fertilizers, offer good opportunity to increase the yield and quality parameters along with soil nutrient status. Hence an attempt was made to study the integrated nutrient management on yield contributing parameters and soil nutrient status in onion during *rabi* season of 2013-14.

The experiment was conducted at All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Rabi* season of 2013-14. The trial was laid out in a Randomized Block Design with three replications having eleven treatments including one control i.e. recommended dose of fertilizers. The onion variety N-2-4-1 was used for present investigation. The soil of the experimental plot was medium black with pH of 8.18, EC (d sm^{-1}) 0.26, $CaCO_3$ 8.37%, organic carbon 0.50% and available N, P_2O_5 and K_2O were 173.42, 16.31, 375.24 $kgha^{-1}$ respectively. The available sulphur was 7.91 mg/kg^{-1}. The details of treatments studied were T_1 – Absolute control, T_2 – 100:50:50 kg NPK ha^{-1}, T_3 -100:50:50 kg NPK + 20 t FYM ha^{-1}, T_4 – 110:40:60:40 kg NPKS + 15 t FYM ha^{-1}, T_5 – 110:40:60 kg NPK + 7.5 t PM + 15 t FYM ha^{-1}, T_6 – 110:40:60:40 kg NPKS + 7.5 t PM ha^{-1}, T_7 – 110:40:60:40 kg NPKS + 7.5 t VC ha^{-1}, T_8 – 110:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t PM ha^{-1}, T_9 – 110:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t VC ha^{-1}, T_{10} – 110:40:60:40 kg NPKS + 3.5 t PM + 3.5 t VC ha^{-1}, and T_{11} – 110:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t PM + 2.5 t VC ha^{-1}. The bio-fertilizers 5 kg each of Azospirillum and Phosphobacteria (PSB) per hectare was applied to all treatment i.e. T_3 to T_{11} except T_1 and T_2.

The half dose of nitrogen and full dose of phosphorus, potassium, FYM (farm yard manure), PM (poultry manure), VC (vermicompost) and Sulpher were given at the time of transplanting and half of nitrogen was applied one month after transplanting i.e. top dressing with urea. The bio-fertilizers 5 kg each of azospirillum and phosphobacteria was applied per hectare to all treatments except treatment T_1 and T_2. Seeds of cultivar N-2-4-1 was sown on raised bed on 19th October, 2013. The main field was prepared to fine tilth and flat beds of 3x2 m^2 was prepared. Eight week old, healthy and uniform seedlings having about 15-20 cm height were used for transplanting. The transplanting was done on 23rd December, 2013 at 15x10 cm spacing. The root portion of the seedlings was dipped into the solution of Azospirillum + PSB for 15 minutes period as per treatment and then transplanted in flat beds. Recommended agronomic practices and plant protection measures were taken up to grow healthy crop. Five randomly selected plants were taken for recording the biometrical parameters like plant height (cm), number of leaves, neck thickness (cm), polar and equatorial diameter of bulb (cm), average weight of bulb (g), % A, B & C grade bulbs, bolting (%), twin bulb (%), total bulb yield (tha^{-1}), marketable bulb yield (tha^{-1}) and the

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total storage losses % as quality parameters. The data was analyzed using method suggested by Panse and Sukhatme (1985). The 10 kg of uniform bulbs of each treatment were used for studying the storage losses from May to October 2014. The soil nutrient status was analyzed before the application of treatments and after the harvesting of the crop by adopting the methods suggested by A.O.A.C. (1990).

To enhance the onion productivity, the balanced nutrition to onion is essential as in the form of organic, inorganic and bio-fertilizers. Significant variations among the treatments were observed for the characters like plant height, number of leaves, neck thickness, polar diameter, equatorial diameter, average weight of bulb, % premature bolters, % doubles, total yield and marketable yield (Table 1). The integrated approach of nutrient application improved these characters when compared to sole application of recommended dose of fertilizer. There is a considerable range of variation was observed form T_1 to T_{11} treatments under study. The absolute control treatment (T_1) recorded the minimum values while T_{11} treatment recorded the maximum values for different characters under investigation. The treatment T_{11} i.e. application of 100:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t PM + 2.5 t VC ha^{-1} recorded maximum plant height (76.60 cm), number of leaves (12.87) and neck thickness (1.26 cm) as compare to T_3 i.e. application of 100:50:50 kg NPK + 20 t FYM ha^{-1} (70.28 cm, 11.37 cm and 0.95 cm, respectively).

With regard to yield and yield contributing parameters, the treatment T_{11} recorded the maximum polar diameter (5.76 cm), equatorial diameter (6.65 cm) and average weight of bulb (79.49 g) than other treatments. The total bulb yield (tha^{-1}) was also maximum in T_{11} treatment i.e. 50.38 tha^{-1} followed by T_{10} (46.17 tha^{-1}) and T_8 (42.76 tha^{-1}). The same trend was also observed for marketable yield (tha^{-1}). This may be due to the present of more % nitrogen in poultry manure than other two organic manures *viz;* FYM and vermicompost. FYM alone in combination with RDF observed low yields of 28.49 tha^{-1}. The beneficial effect of organic manure on yield and other characters could be attributed to the fact that the decomposition and mineralization of organic manures made the nutrients readily available to the plant (Singh and Asrey, 2005) and also had solubilizing effect of fixed form of nutrients in the soil (Kumaran, *et.al.* 1998).

On an average 40-50 percent increase in total bulb yield by combination of organic, inorganic and bio-fertilizers in onion crop over the only recommended dose of fertilizer was found. The maximum increase in total bulb yield was recorded in treatment T_{11} (110:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t PM + 2.5 t VC ha^{-1}) over the only recommended dose of fertilizers i.e. T_3 (28.49 tha^{-1}) i.e. 100:50:50 kg NPK + 20 t FYM ha^{-1}) and T_1 i.e. absolute control, which revealed minimum total yield (20.57 tha^{-1}). These results are in close agreement with

Table 2: Total storage losses (%) in onion as influenced by INM.

Treatment	Days after storage					
	30	60	90	120	150	180
T_1	6.41	9.56	15.39	20.61	25.55	29.63
T_2	8.04	11.32	19.36	26.86	29.73	35.50
T_3	6.46	11.62	22.87	26.85	33.85	39.00
T_4	6.33	8.99	17.03	20.53	31.12	37.93
T_5	5.94	8.85	17.99	21.53	33.04	39.82
T_6	7.55	12.26	21.81	27.06	35.20	43.46
T_7	6.96	12.31	20.88	30.39	36.56	41.71
T_8	6.41	12.44	19.37	25.16	34.87	40.89
T_9	5.67	8.66	16.22	25.27	33.02	39.10
T_{10}	6.19	10.39	21.10	30.61	37.45	43.88
T_{11}	6.48	11.71	20.86	31.34	39.49	46.76
S.E.±	1.97	1.91	2.69	2.79	2.80	3.04
CD at 5%	NS	NS	NS	NS	NS	NS

Table 1: Yield and yield contributing parameters as influenced by INM in onion.

Treatments	Plant height (cm)	Number of leaves	Neck thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	Av. Weight of bulb (g)	% AGB	% BGB	% CGB	% Bolters	% Doubles (Twin bulbs)	Total yield (t/ha)	Marketable yield (t/ha)
T_1	62.20	9.07	0.81	4.21	4.66	53.14	13.21	61.87	23.26	0.30	1.36	20.57	20.23
T_2	66.27	10.18	0.87	4.45	4.98	57.82	14.88	63.99	18.40	0.77	1.96	25.44	24.75
T_3	70.28	11.37	0.95	4.90	5.40	61.46	17.50	62.90	17.73	0.38	1.49	28.49	27.96
T_4	68.87	10.31	0.93	4.56	5.11	60.47	17.92	64.33	15.90	0.45	1.40	27.20	26.70
T_5	72.05	11.13	1.01	5.09	5.70	63.38	18.41	64.98	14.26	0.78	1.57	31.18	30.45
T_6	72.69	11.28	1.04	5.14	5.91	65.25	19.86	63.79	14.59	0.35	1.41	35.55	34.93
T_7	74.89	11.59	1.14	5.22	5.97	70.98	20.38	60.67	16.25	0.75	1.95	39.26	38.20
T_8	75.83	11.87	1.22	5.27	6.09	71.92	22.46	58.40	16.97	0.80	1.37	42.76	41.84
T_9	71.63	11.00	1.07	5.11	5.88	64.12	20.11	61.55	15.35	0.78	2.21	40.15	38.95
T_{10}	74.77	12.35	1.24	5.52	6.33	75.52	21.30	59.57	17.25	0.43	1.45	46.17	45.31
T_{11}	76.60	12.87	1.26	5.76	6.65	79.49	23.74	62.85	10.70	0.72	1.99	50.38	49.01
S.E.±	2.33	0.45	0.05	0.19	0.22	2.89	1.95	3.95	1.52	0.03	0.06	1.52	2.07
CD at 5%	6.87	1.32	0.17	0.56	0.66	8.53	5.76	NS	4.49	0.11	0.20	4.48	6.11

AGB: A grade bulbs, BGB : B grade bulbs, CGB : C grade bulbs.

Table 3: Soil nutrient status as influenced by INM in onion.

Treatments	PH (1:2.5)	EC (d sm^{-1})	Organic carbon (%)	$CaCO_3$ (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Available Sulphur (mg/kg)
T_1	8.20	0.28	0.51	8.41	153.50	14.29	340.92	7.38
T_2	8.18	0.30	0.52	8.44	177.17	16.01	376.15	8.08
T_3	8.16	0.34	0.56	8.53	182.88	18.17	381.00	8.43
T_4	8.17	0.33	0.54	8.49	181.04	18.23	382.41	8.59
T_5	8.16	0.36	0.55	8.51	183.16	19.56	383.74	8.38
T_6	8.15	0.34	0.54	8.57	183.05	19.78	376.28	9.14
T_7	8.14	0.38	0.56	8.63	182.93	17.10	385.63	9.65
T_8	8.13	0.39	0.58	8.65	183.27	18.43	382.80	9.84
T_9	8.11	0.38	0.56	8.58	179.23	17.58	376.72	9.33
T_{10}	8.09	0.36	0.59	8.68	180.01	17.25	378.62	10.32
T_{11}	8.07	0.41	0.62	8.74	184.06	20.03	386.90	10.61
S.E.±	0.03	0.03	0.01	0.02	1.23	0.99	0.83	0.34
CD at 5%	NS	NS	0.05	0.08	3.65	2.93	2.46	0.99
Initial values	8.18	0.26	0.50	8.37	173.42	16.31	375.24	7.91

those of Jayathilake (2002), Sharma *et al.,* (2000) and Khandelwal (2010). The total marketable bulbs of different sizes were graded into A grade (above 6.5 cm), B grade (6.5 to 4.5 cm) and C grade (4.5 to 3.5 cm) size bulbs. The percentage of premature bolters and doubles (twin bulbs) regarded as unmarketable bulbs. The A grade bulbs percentage recorded in the range of 13.21 to 23.74. The B grade was 58.40 to 64.98 and was non-significant and C grade was 10.70 to 23.26 percent. The bolters ranged from 0.30 to 0.72% and the doubles (twin bulbs) percentage was in the range from 1.36 to 2.21 in various treatments.

The storage of onion bulbs was influenced by various INM treatments. The treatment T_{11} recorded the maximum losses *viz;* 6.48, 11.71, 20.86, 31.34, 39.49 and 46.76% as compare to absolute control i.e. T_1 *viz;* 6.41, 9.56, 15.39, 20.61, 25.55 and 29.63% total storage losses (sprouting, rotting and PLW losses) for 30, 60, 90, 120, 150 and 180 days after storage (Table 2). The increased level of nutrient applications were responsible for increasing the total losses in onion. Similar findings were also reported by Mukeshkumar (2000). The analysis of soil nutrient status (Table 3) before the treatment application and also after the harvest of the crop revealed that the organic carbon and available N was found significantly more in poultry manure treated plot alone or in combination with RDF. Very low organic carbon and available N content was observed in RDF (T_3), T_1 and T_2 treatments. Similar trend was observed with available P_2O_5, K_2O and Sulphur. The EC was maximum in treatment T_{11} (0.41). The initial value was 0.26. The $CaCO_3$ content was also maximum in T_{11} (8.74) and minimum in T_1 (8.41). the study revealed that use of inorganic fertilizers alongwith FYM, PM, VC and bio-fertilizers results in significant improvement in available N, P, K and S status of the soil. Similar findings were also reported by Siag and Yadav (2004).

Considering the yield contributing characters, storage losses and soil nutrient status, it can be concluded that for obtaining higher yields of onion through the use of integrated nutrient management system, the application of 110:40:60:40 kg NPKS + 7.5 t FYM + 2.5 t PM + 2.5 t VC ha^{-1} + bio-fertilizers (5 kg each of Azospirillum and Phosphobacteria) should be applied to onion crop. The integrated nutrient management in onion helps in enhancing the yield attributes in *rabi* onion by sustaining the soil health under western Maharashtra conditions.

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