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Effect of integrated management of inorganic and organic fertilizers on yield, soil fertility and storage life of *Rabi* onion (*Allium cepa* L.)

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Abstract
A field experiment was conducted during *rabi* season in 2011-12 at Vegetable Research Farm of C.S.A. University of Agriculture and Technology at Kalyanpur, Kanpur to study the effect of inorganic and organic fertilizers and their combination in various proportion on bulb yield attributes and storage life of onion (*Allium cepa* L.). The experiment was laid out in randomized block design (RBD) using ten replications. Among different fertilizer management practices; application of local recommendation 100:50:80:40 kg ha^{-1} NPKS + bio-fertilizers were recorded significantly higher potential for total bulb yield (20.57 t ha^{-1}) and marketable bulb yield (20.01 t ha^{-1}). Besides, the application of 110:40:60:40 NPKS kg ha^{-1} along with organic manures reduced physiological weight loss (PLW %) and increased the soil fertility (P) (K) and (S), respectively as compared to local recommendation of treatments. Hence, it can be recommended that NPKS dose along with bio-fertilizers (100:50:80:40 kg ha^{-1} + *Azospirillum*+ PSB @ each 5 kg ha^{-1}) for more productive and resource use efficient than corresponding fertilizer management for farmers under Central Uttar Pradesh conditions.

Keywords: Bulb yield, onion, storage, fertility

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops cultivated extensively in India and it belongs to family *Alliaceae*. Onion is an indispensable item in every kitchen as vegetable and condiment, therefore commands, an extensive internal market. Onion is liked for its flavour and pungency which is due to the presence of a volatile oil '*allyl propyl disulphide*'- organic compound rich in sulphur. Onion is used in pharmaceutical preparations due to its medicinal values. Onion is also known to cure heart diseases as it checks the deposition of cholesterol in blood vessels (Barakade *et al.,* 2011) [2]. Continuous application of inorganic fertilizers to soil tends to reduce the yield of crops over time by affecting the soil properties. This calls for use of organic manures in crop production (Biswas and Bendi, 1989) [3]. Organic fertilizers have positive effect on root growth by improving the root rizosphere conditions (structure, humidity *etc*.) and also plant growth is encouraged by increasing the population of microorganisms (Shaheen *et al*., 2007) [8].
Onion is a shallow rooted and high nutrient demanding vegetable; its productivity depends on soil fertility status and nutrients applied. Under inadequate fertilization considerable yield losses have been reported (Balemi *et al.,* 2007) [1]. The increasing cost and decreasing availability of inorganic fertilizers in peak periods is making crop production uneconomical particularly for small and marginal farmers. Therefore it is essential to evolve and adopt a suitable strategy for integrated nutrient supply by using combination of inorganic fertilizers, organic manures and bio-fertilizers. Keeping in view these aspects, the present research work was initiated to develop a suitable fertilizer package in combination of organic manure and chemical fertilizers for sustainable onion production and to investigate the post-harvest soil properties.

Materials and Methods
The investigation was carried out at the Vegetable Research Farm, C.S.A. University of Agriculture and Technology at Kalyanpur, Kanpur for during *Rabi* season in 2011- 2012. The experiment site is located at 26° 29 N latitude and 80° 18 E longitudes with an altitude of 125.9 m above from mean sea level.

The initial soil fertility status of experimental plot was well drained clay loam with pH 7.50 and EC 0.80 ds m^{-1}. The available N, P, K and S content of the soil were 248.11, 11.14, 168.41 and 13.10 kg ha^{-1}, respectively. The experiment was laid out in Randomized Block Design with four replications and consisting of ten treatments are presented in Table (1). The onion cultivar Kalyanpur Red Round (KRR) was sown in nursery beds during November and transplanted in January with space of 15x10 cm between rows and plants, respectively. All organic manures like farm yard manure (FYM), vermicompost (VC) and poultry manure (PM) and bio-fertilizers *viz*., *Azospirillum* and phosphorus solubilizing bacteria each @ 5 kg each ha^{-1} were spread uniformly in the respective plots and incorporated in the soil to a depth of 6-8 cm before transplanting. The inorganic fertilizers (NPKS kg ha^{-1}) were applied through urea, single super phosphate, murate of potash and elemental sulphur. The recommended full dose of phosphorus, potassium, sulphur and half dose of nitrogen were applied as basal dose while the remaining nitrogen was applied in two equal splits during 30 and 45 days after transplanting. Recommended cultural and plant protection practices were followed equally in all the plots as and when required. The bulbs were harvested at full maturity stage when more than 50% leaves dried and fallen. The well cured bulbs, 5 kg^{-1} from each treatment were stored in low cost onion storage structure for storage study for a period of four months. After proper curing and neck cutting the observations on yield contributing characters and marketable bulb yield (A, B and C grade bulbs) were recorded. The data recorded on various parameters were subjected to statistical analysis according to standard procedure.

Table 1: Treatment details

Notations	Treatment details
T_1	100:50:80:40 kg NPKS with bio-fertilizers (local recommendation)
T_2	100:50:80:40 kg NPKS without bio-fertilizers (local recommendation)
T_3	150:50:80:50 kg NPKS + 20 tha^{-1} FYM
T_4	110:40:60:40 kg NPKS +15 tha^{-1} FYM
T_5	110:40:60:40 kg NPKS + 7.5 tha^{-1} PM
T_6	110:40:60:40 kg NPKS + 7.5 tha^{-1} VC
T_7	110:40:60:40 kg NPKS +7.5 tha^{-1} FYM+3.75 tha^{-1} PM
T_8	110:40:60:40 kg NPKS +7.5 tha^{-1} FYM + 3.75 tha^{-1} VC
T_9	110:40:60:40 kg NPKS +3.75 tha^{-1} PM+ 3.75 tha^{-1} VC
T_{10}	110:40:60:40 kg NPKS + 5 tha^{-1} FYM +2.5 tha^{-1} PM+ 2.5 tha^{-1} VC

FYM: farm yard manure; PM: poultry manure; VC: vermicompost

Results and Discussion

The data on yield and yield attributes parameters, quality and storage life as well as soil fertility status after harvest the crop as influenced by combined application of organic and inorganic fertilizes of the different treatments are presented in Table 2 and 3.

Yield attributes and quality

The results on yield attributes and quality parameter like average bulb weight (g), A grade bulbs (%), B grade bulbs (%), C grade bulbs (%), marketable yield (t ha^{-1}) and total yield (t ha^{-1}) as well as quality parameter such as T.S.S (%) were significantly influenced by the various treatments. Average weight of bulb is an important parameter in promoting the yield of the onion crop and direct and positive correlation with bulb yield. The data registered on maximum average weight of bulb (69.48 g) was found in T_5 whereas the minimum average bulb weight was found in treatment T_2 with the value of (49.08 g). The increased availability of nutrients and production of growth promoting substances might have caused faster cell elongation and multiplication in turn increased size of the bulb. It was also reported by Kuldeep Sevak *et al.,* (2012) [6] and Dalal and Nandkar (2010) [4]. The bulbs are graded into different categories on the basis of size for marketable bulb yield. However, A and B grade bulbs was found in range between (33.09 to 43.31%) and (32.44 to 39.53 %), respectively whereas, C grade bulbs was found in range between (17.80 to 31.27 %) of different treatments as influenced by application of organic and inorganic fertilizer combinations. In general there was maximum A and B grade bulbs was found in T_{10} (43.31 %) and T_7 (39.53 %) whereas maximum C grade bulbs was recorded in T_4 with the value of 31.27 %. Krishnamurthy and Sharanappa (2005) [5] report that the favorable effect of integrated nutrient management through both inorganic fertilizers and organic manures on produced higher percentage of large and medium grade bulbs than small grade bulbs. The results presented on total bulb yield and marketable bulb yield of onion crop revealed significant variations among different treatments due to inorganic and organic fertilizers along with bio-fertilizers combination. In the present study, the maximum marketable and total bulb yield was observed in T_1 (20.01 and 20.57 t ha^{-1}, respectively) with the application of local recommendations of inorganic fertilizers along with bio-fertilizer combination which is followed by T_8 (19.78 and 20.14 t ha^{-1}) and T_3 (18.78 and 19.30 t ha^{-1}), respectively. The significant increase in yield and yield parameters due to *Azospirillum* may be an account of its direct role in nitrogen fixation, production of phytohormone like substances and increased uptake of nutrients such as nitrogen. This effect was in conformity with the results obtained by Subbiah (1994) in chilli and onion, Nanthakumar and Veeraragavathatham (2000) [7] in brinjal and Yadav *et al.,* 2005 [12] in onion.

Total soluble solid (TSS) is important parameter of onion as indicated that total sugars are present in the bulb. However, the maximum TSS was recorded in T_3 (14.36 %) which is followed by T_2 (14.26 %) and T_4 (12.80 %), respectively. The improvement in quality of onion with application of organic along with recommended dose of chemical fertilizers may be attributed to the enhanced metabolic activities synthesizing higher amounts of acids that contribute to synthesis of TSS %, acidity and ascorbic acid in vegetables (Yogita *et al.,* 2012).

Soil fertility

The data recorded on soil properties as influenced by various treatments have been presented in Table 3. The initial pH of soil was 7.50. It revealed from the result that there was marginal increase in soil pH from 7.39 to 8.30 after harvest of crop. Soil EC (ds m^{-1}) was recorded maximum in treatment T_7 (0.36 ds m^{-1}) followed by treatment T_5, T_6 and T_7 with the same value of 0.31 ds m^{-1}. The soil available N, P, K and S status after harvest of crops was influenced by significant due to different treatments. However, the maximum N, P, K and S was found in T_2, T_6, T_3 and T_{10} with the value of (205.13, 21.00, 242.66 and12.16 kg ha^{-1}, respectively). From these studies it is clearly seen that use of inorganic fertilizers along with FYM, PM, VC and bio-fertilizers resulted in significant improvement in available N, P and K status of the soil after harvest of crop. Similar trends of results were reported by Sharma *et al.,* 2000 [9] and Singh and Pandey (2006) [10].

Storage life

The results of storage life revealed that combination of organic and inorganic fertilizers application of onion crop did not show significant effect on storage (Table 2). The storage losses were almost affected by the rotting and sprouting of onion bulbs and maximum cumulative physiological weight loss was recorded during 90 to 120 days. However, maximum PLW (%) was recorded in T_1 (50.23) and minimum was recorded in T_{10} (34.99). In respect of rotting bulbs are not produce in T_1, T_2, T_4 and T_8, respectively whereas same conditions of sprouting bulbs in T_1, T_2, T_3, T_7 and T_9, respectively are not produce after four months of storage. Therefore, The chemical must have played a vital role in modifying the rate of gaseous exchange that takes place through the surface of the bulbs by changing the ratio of carbon dioxide and oxygen inside the bulbs, thus minimizing the respiration and transpiration rate of the bulbs in turn must have reduced the rate of moisture loss and ultimately prevented the loss in weight in onion.

Table 1: Influence of inorganic and organic fertilizers on yield, TSS and storage behavior in onion crop

Treatments	ABW (g)	AGB (%)	BGB (%)	CGB (%)	MY (t ha^{-1})	TY (t ha^{-1})	TSS (%)	Cumulative storage loss after four months		
								PLW (%)	Rotting (%)	Sprouting (%)
T_1	51.86	39.48	37.08	17.80	20.01	20.57	12.70	50.23	0.00	0.00
T_2	49.08	34.74	35.89	26.29	18.33	18.95	14.26	44.06	0.00	0.00
T_3	56.02	34.98	33.18	29.10	18.78	19.30	14.36	42.34	11.88	0.00
T_4	53.08	33.09	33.43	31.27	17.60	17.96	12.80	47.34	0.00	0.39
T_5	69.48	36.26	37.42	25.54	16.61	17.10	11.83	41.78	15.61	2.68
T_6	58.76	37.79	36.96	24.06	17.00	17.51	11.46	44.64	12.43	0.35
T_7	61.10	35.65	39.53	23.73	17.84	18.41	12.36	37.44	15.69	0.00
T_8	63.09	36.23	34.47	27.57	19.78	20.14	11.26	40.09	0.00	2.19
T_9	68.14	35.59	32.44	30.14	17.88	18.36	11.43	40.88	5.85	0.00
T_{10}	61.73	43.31	38.55	22.70	15.85	16.74	10.93	34.99	20.74	0.65
CD (*P =0.05*)	4.55	6.81	5.72	8.51	1.33	1.21	3.26	3.43	2.31	0.43
CV %	4.48	10.81	9.29	19.22	3.59	3.19	15.40	14.74	32.29	57.70

ABW=Average bulb weight, AGB=A grade bulbs, BGB= B grade bulbs, CGB=C grade bulbs, MY= Marketable yield, TY=Total yield, TSS=Total soluble solids, PLW= Physiological weight loss

Table 2: Soil properties after harvest of onion crop as influenced by different treatments

Treatments	Available nutrient status (kg ha^{-1}) after harvest of crop					
	pH	EC	N	P	K	S
T_1	7.87	0.30	154.09	12.66	154.00	9.83
T_2	7.86	0.25	205.13	12.66	132.66	9.60
T_3	8.02	0.23	169.20	12.66	242.66	9.73
T_4	8.05	0.27	192.15	15.00	150.00	10.10
T_5	8.10	0.31	180.55	16.00	151.66	10.50
T_6	7.39	0.31	188.30	21.00	154.33	11.33
T_7	7.60	0.36	182.86	18.33	150.00	10.00
T_8	7.86	0.28	179.53	14.33	160.00	10.50
T_9	8.30	0.27	190.45	13.66	215.66	10.50
T_{10}	7.87	0.31	186.07	15.33	196.66	12.16
CD (*P =0.05*)	0.81	0.14	57.62	5.80	23.33	1.45
CV %	6.01	28.54	18.37	22.61	7.96	8.10

Conclusion

Based on the present study, it can be concluded that local recommendation of N, P, K and S @100:50:80:40 along with bio-fertilizers (*Azospirillum*+PSB @ each 5 kg ha^{-1}) recorded significantly higher bulb yield over the remaining treatments. Furthermore, combined application of organic manures with N, P, K and S @ 110:40:60:40 kg ha^{-1} reduced physiological weight loss (PLW %) and increased the soil available nutrients (P), (K) and (S) status after harvest of crop in *rabi* onion production under central Uttar Pradesh condition.

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