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Role of various fertilizers and azotobacter (*biofertilizer*) on the performance of kharif onion *(Allium cepa* L.) cv. Agrifound Dark Red

Amarjeet Kaur and Snehdeep Singh

Abstract
To assess the role of various fertilizers and azotobacter (*biofertilizer*) on the performance of kharif onion (*Allium cepa* L.) cv. Agrifound Dark Red a field experiment was carried out in the experimental plot of Department of Horticulture, Khalsa College, Amritsar during 2017-18. The experiment was laid out in Randomized Block Design with eleven treatments replicated three times. Results of the study revealed that the combined application of organic, inorganic fertilizers and *biofertilizer*s had significant effect on the physical and biochemical characteristics of kharif onion. It is evident from the results that the treatment T_{10} (50% RDF + 50% vermicompost + 25% *biofertilizer* (azotobacter) (4Kg/h) was the remarkable treatment for improving the physico-chemical properties of kharif onion in terms of maximum plant height (56.61 cm), leaf number (11.52), neck thickness (2.69 cm), bulb diameter (2.49 cm) and bulb weight (79.35 cm). Increase in yield (256.80 q/ha) and TSS (14.3 ^{0} Brix) was also registered under the same treatment respectively.

Keywords: kharif onion, *biofertilizer*s, bulb, vermicompost, azotobacter, ^{0}brix, yield

Introduction

Onion (*Allium cepa* L.) is a member of the family Alliaceae and is one the most important vegetable crop cultivated extensively in India and world, whose utility is ranked second to tomatoes (Gwari *et al.* 2014) [6]. It is known as "Queen of kitchen". It is an indispensable item in every kitchen and used to enhance flavour of different recipes. Nutritive value of onion varies variety to variety, small size onion is more nutritive then big size onion. It is used as green as well as bulb and because of its specific flavour, pungency and culinary properties it has become an Indispensible item in every kitchen as condiment and vegetables. Onion is preferred for its flavour and pungency which is due to the presence of volatile sulphur compound Allyl-propyl disulphide. It is used for local consumption and also is an exportation commodity. It is a biennial plant but usually but s usually grown as annuals and is available in varieties of colours such as yellow, brown, white and red onions which is due to quercetin (Gurjar *et al.* 2017) [5]. It contains several anticancer agents which have shown to prevent cancer in animals (Manach *et al.* 2005) [13]. However researcher beneficial compound called quercetin present in onion has shown to be powerful antioxidant (*Yadav et al.* 2015) [29]. It is also found applicable in the treatment of coughs, snake bite and hair loss. In addition it is used by athletes to rub down their muscles in order to firm it and for blood balance as well as to facilitates bowel movement. The pungent juice of onion has been used as insect repellents as well as dyes used in fabric industries. Onion can be served as cooked vegetable or part of a prepared savory dish, but can also be eaten as raw. They are pungent when chopped and contain certain chemical substances which irritate the eyes. Onion is a heavy feeder of mineral elements. A crop of 35 tonnes per hectares removes approximately 120 kg of N, 50kg of P_2O_5 and 160 kg of K_2O per ha (Mohanty *et al.* 2015) [17]. For obtaining high yields per unit area and to fulfill the rising demand of onion during lean period (Dec-Jan in Punjab) farmer use excessive amount of inorganic fertilizers to achieve a higher yield. It provides excellent opportunities to overcome all the imbalances behind sustaining soil health, enhancing crop production and also optimizes the benefit from all possible sources of plant nutrients in an integrated manner (Bagali *et al.* 2012) [2]. Hence, organic manures such as FYM, vermicompost can serve as an alternative to mineral inorganic fertilizers for improving soil structure and microbial biomass (Suresh *et al.* 2004) which lead to mobilization of many essential nutrients of soil. Besides organic fertilizers has positive effect on root growth by improving the root structure, humidity etc leading to an increase in onion yield. (Shaheen *et al.* 2007) [25]. Anyhow, organic manures alone are unable to give economic yield and it is vital to find appropriate combinations of inorganic and organic manures to obtain financially viable yield of crops (Seran *et al.* 2010) [24]. The primary goal of integrated nutrient management is to combine old and new methods of nutrient management into ecologically sound and ecologically viable farming systems that utilize available organic and inorganic sources of nutrients in a Judicious and efficient way. So INM provides excellent opportunities to overcome the imbalance beside sustaining soil health and enhancing production of onion (Bagali *et al.* 2012) [2]. Nutrient management reduces the inorganic fertilizer requirement to enhance nutrient use efficiency and maintains soil quality in terms of physical, chemical and biological properties. Thus keeping in view the above facts, the present study was undertaken to evaluate the effect of integrated nutrient management in kharif onion.

Materials and Methods

The present investigation on Role of various fertilizers and azotobacter (*biofertilizer*) on the performance of kharif onion (*Allium cepa* L.) cv. Agrifound Dark Red was carried out in an experiment plot of Department of Horticulture, Khalsa College Amritsar during 2017-18. The field experiment was carried out in randomized block design with eleven treatments (T_1-Control; T_2-100% Vermicompost; T_3-100% Farmyard manure (FYM); T_4-100% RDF; T_5- 50% RDF + 50% Farmyard manure (FYM); T_6-50% RDF + 50% Vermicompost (VC); T_7-25% RDF + 75% Farmyard manure (FYM); T_8-50% RDF + 50% Farmyard manure (FYM) + *Biofertilizer* (Azotobacter) (4Kg/h); T_9-25% RDF + 75% Vermicompost (VC); T_{10}-50% RDF + 50% Vermicompost (VC) + *Biofertilizer* (Azotobacter) (4Kg/h); T_{11}-100% *Biofertilizer* (Azotobacter) replicated thrice. Onion seedlings of the cv. Agri found Dark Red were raised in the nursery beds of the size of 1.5 × 1.5 m and seeds were sown thinly in rows, about 5 cm apart. Approximately 45 days old healthy seedlings were transplanted in the main field. Row to row distance was maintained at 15 cm and plant to plant at 7.5 cm. Various observations on physico-chemical characters were recorded. Full dose of RDF (40 kg N, 20 kg P_2O_5 and 20 kg K_2O/acre) was applied as per package of practices for cultivation of vegetables, PAU, Ludhiana. Half dose of nitrogen along with full dose of phosphorus and potassium was applied as basal dose at the prepared beds. The remaining half dose of nitrogen was top dressed after four weeks of transplanting. Organic manures (FYM) (20 ton/ha), vermicompost (6 ton/ha) and *biofertilizer*s (4kg/ha) was applied before showing as basal dose.

Results and Discussion

The results revealed that the maximum plant height (31.73 cm) at 30 days,(53.53 cm) 60 days, (58.56 cm) 90 days and (56.61cm) at harvest was numerically maximum in treatment T_{10} (50% RDF + 50% Vermicompost (VC) + 25% *Biofertilizer* (Azotobacter) (4Kg/h) whereas, minimum plant height was under control. This might be due to the fact that the application of integrated nutrient management, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improved the plant height. These findings are in agreement with the findings of Jayathilake *et al.* (2002) [8], Jayathilake *et al.*(2003) [9], Abbey and Kanton (2003) [1], Reddy and Reddy (2005) [21], Mahmoud (2006), Patel *et al.* (2008a) [19], Sankar *et al.* (2008) [23], Sankar *et al.*(2009) [22], Kanaujia *et al.* (2009) [11], Ethel Ngullie Singh and Singh (2009) [4], Nandal and Bedi (2010) [18] and Prabhakar *et al.* (2017) [20] in onion.

Table 1: Plant height (cm) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion at 30, 60, 90 DAT and at harvest

Treat. Symb.	Treatments	Plant height(cm)			
		30 DAT	60 DAT	90 DAT	Harvest
T_1	Control	25.94	44.89	49.81	49.95
T_2	100% Vermicompost	26.87	45.47	50.93	50.11
T_3	100% Farmyard manure (FYM)	27.57	45.22	52.00	52.08
T_4	100% RDF	31.53	51.21	56.47	56.84
T_5	50% RDF + 50% Farmyard manure (FYM)	29.70	51.00	55.21	55.73
T_6	50% RDF + 50% Vermicompost (VC)	30.67	51.07	56.20	56.61
T_7	25% RDF + 75% Farmyard manure (FYM)	27.62	47.43	52.64	52.73
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	31.71	51.73	57.33	57.85
T_9	25% RDF + 75% Vermicompost (VC)	27.71	50.57	54.93	54.98
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	31.73	53.53	58.56	56.61
T_{11}	100% Biofertilizer (Azotobacter)	29.01	49.21	54.41	54.34
	S. Em.	0.2	0.40	0.40	0.38
	C.D. 5%	0.60	1.23	1.20	1.13

The results revealed that number of leaves/ plant were recorded numerically significantly higher (5.36, 9.49, 11.40 and 11.52) at 30, 60, 90 days and at harvest stage in treatment T_{10} with minimum number of leaves/plant (4.47) in control (T_1). Probable reasons for more number of leaves, might be due to promotive effects of integrated nutrient management on vegetative growth which ultimately lead to more photosynthetic activities. These findings are in agreement with the findings of Jayathilake *et al.* (2002) [8], Jayathilake *et al.* (2003) [9], Mondal *et al.* (2004), Reddy and Reddy (2005) [21], Patel *et al.* (2008a) [19], Sankar *et al.* (2008) [23], Sankar *et al.* (2009) [22], Kanaujia *et al.* (2009) [11], Nandal and Bedi (2010) [18], Prabhakar *et al.* (2017) [20] and Jawadagi *et al.* (2012) [10].

Table 2: Leaf number as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion at 30, 60, 90 DAT and at harvest

Treat. Symb.	Treatments	Number of leaves per plant			
		30 dat	60 dat	90 dat	harvest
T_1	Control	4.45	8.11	8.85	9.28
T_2	100% Vermicompost	4.61	8.27	9.65	9.67
T_3	100% Farmyard manure (FYM)	5.03	8.35	10.24	9.95
T_4	100% RDF	5.20	9.01	10.81	10.90
T_5	50% RDF + 50% Farmyard manure (FYM)	5.06	8.94	10.58	10.61
T_6	50% RDF + 50% Vermicompost (VC)	5.16	9.01	10.64	10.67
T_7	25% RDF + 75% Farmyard manure (FYM)	5.02	8.64	10.02	10.12
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	5.29	9.15	10.84	10.89
T_9	25% RDF + 75% Vermicompost (VC)	5.03	8.81	10.25	10.31
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	5.36	9.49	11.40	11.52
T_{11}	100% Biofertilizer (Azotobacter)	5.01	8.78	10.29	10.29
	S. Em.	0.03	0.05	0.07	0.07
	C.D. 5%	0.10	0.15	0.21	0.20

Data on neck thickness revealed that the maximum neck thickness (0.52 cm) at 30 DAT, 1.87 cm, 2.67 and 2.69 cm at 60, 90 days and at harvest was found in the treatment T_{10} (50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)* whereas, minimum neck thickness was recorded in absolute control (T_{10}). Variation in neck thickness might be due to the inherent genetic makeup of the genotypes, which is some way influenced by quantity of irrigation water such as more irrigation at the growth period leading to increased neck thickness of the bulb. Similar results were reported by Mahanthesh *et al.* (2005) [14] and Kanaujia *et al.* (2009) [11] in onion plants.

Table 3: Neck thickness (cm) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion at 30, 60, 90 DAT and at harvest

Treat. Symb.	Neck thickness (cm)				
	Treatments	30 dat	60 dat	90 dat	Harvest
T_1	Control	0.35	1.63	2.41	2.44
T_2	100% Vermicompost	0.36	1.64	2.47	2.49
T_3	100% Farmyard manure (FYM)	0.36	1.65	2.45	2.47
T_4	100% RDF	0.43	1.64	2.54	2.55
T_5	50% RDF + 50% Farmyard manure (FYM)	0.41	1.69	2.451	2.52
T_6	50% RDF + 50% Vermicompost (VC)	0.42	1.69	2.53	2.53
T_7	25% RDF + 75% Farmyard manure (FYM)	0.39	1.67	2.46	2.48
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	0.45	1.71	2.56	2.57
T_9	25% RDF + 75% Vermicompost (VC)	0.40	1.67	2.44	2.46
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	0.52	1.82	2.67	2.69
T_{11}	100% Biofertilizer (Azotobacter)	0.40	1.68	2.51	2.52
	S. Em.	0.02	0.01	0.01	0.01
	C.D. 5%	0.06	0.03	0.05	0.05

Diameter of bulb were recorded at various growth stages viz. 30, 60 and 90 days after planting and at harvest. The data shows that neck thickness was comparatively lower at the initial stage (30 DAT) and their after increased upto harvest with the maximum bulb diameter (0.79 cm, 1.86 cm, 2.04 cm and 2,34 cm) at 30, 60, 90 and at harvesting day was found in the treatment T7 containing (50 % RDF + 50 % Vermi-compost + PSB. This might be due to the reason that the application of major and micronutrients by integrated nutrient management, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the diameter of bulb. Similar results were reported by Jayathilake *et al.* (2002) [8], Jayathilake *et al.* (2003) [9], Abbey and Kanton (2003) [1], Krishnamurthy (2005) [12], Mahanthesh *et al.* (2005) [14] Kanaujia *et al.* (2009) [11], Yoldas *et al.* (2011) [31], Prabhakar *et al.* (2017) [20] and Srivastava *et al.* (2012) [28] in onion respectively.

Table 4: Bulb diameter (cm) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion at 30, 60, 90 DAT and at harvest

Treat. Symb.	Treatments	Bulb diameter (cm)			
		30 dat	60 dat	90 dat	Harvest
T_1	Control	0.37	1.77	2.04	2.10
T_2	100% Vermicompost	0.43	1.84	2.02	2.11
T_3	100% Farmyard manure (FYM)	0.46	1.85	2.09	2.12
T_4	100% RDF	0.59	1.76	2.23	2.25
T_5	50% RDF + 50% Farmyard manure (FYM)	0.51	1.89	2.15	2.18
T_6	50% RDF + 50% Vermicompost (VC)	0.54	1.91	2.17	2.19
T_7	25% RDF + 75% Farmyard manure (FYM)	0.47	1.86	2.13	2.15
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	0.67	1.84	2.32	2.34
T_9	25% RDF + 75% Vermicompost (VC)	0.48	1.87	2.14	2.16
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	0.79	1.86	2.47	2.49
T_{11}	100% Biofertilizer (Azotobacter)	0.53	1.84	2.18	2.20
	S. Em.	0.02	0.01	0.01	0.01
	C.D. 5%	0.08	0.03	0.04	0.05

Fresh weight of bulb per plot in different treatments of organic manure, inorganic fertilizers and *biofertilizer*s depicted that significantly maximum (79.35 g) fresh weight of bulb was exhibited in the treatment T_{10}(50% RDF + 50% Vermicompost (VC)+25% *Biofertilizer (Azotobacter) (4Kg/h)* whereas, the minimum fresh weight of bulb (40.23 g) was observed in T1 (Absolute control). Probable reason for increased weight of bulb was due to the presence of humus substances could have mobilized the reserve food materials to the sink through the increased activity of hydrolyzing and oxidizing enzymes. Similar results have been reported by Jayathilake *et al.* (2002) [8], Jayathilake *et al.* (2003) [9], Abbey and Kanton (2003) [1], Krishnamurthy (2005) [12], Mahanthesh *et al.* (2005) [14], Mahmoud (2006), Sankar *et al.* (2008) [23], Sankar *et al.* (2009) [22], Ethel Ngullie Singh and Singh (2009) [4], Hari *et al.* (2009) [, Yoldas *et al.* (2011) [31], Prabhakar *et al.* (2017) [20], Srivastava *et al.* (2012) [28] and Shaheen *et al.* (2013) in onion.

Table 5: Bulb weight (g) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion

Treat. Symb.	Treatments	Fresh weight of bulb(g)	Dry weight of bulb(g)
T_1	Control	40.23	4.48
T_2	100% Vermicompost	45.33	5.65
T_3	100% Farmyard manure (FYM)	55.04	5.68
T_4	100% RDF	70.11	9.52
T_5	50% RDF + 50% Farmyard manure (FYM)	66.67	9.25
T_6	50% RDF + 50% Vermicompost (VC)	66.97	9.36
T_7	25% RDF + 75% Farmyard manure (FYM)	63.24	6.64
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	78.33	9.68
T_9	25% RDF + 75% Vermicompost (VC)	64.12	8.93
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	79.35	10.44
T_{11}	100% Biofertilizer (Azotobacter)	62.93	7.96
	S. Em.	3.91	2.64
	C.D. 5%	10.21	7.15

According to the results treatment T_{10} (50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*) recorded the maximum dry weight 10.44 g while, the minimum 4.48 g dry weight of bulb was noted in treatment T1 (Absolute control). Probable reason for increased dry matter recovery per cent due to humus substances present in organic manure. Ortho dihydric, phenols of humic acid that inhibit the IAA. Oxidase leads to prolonged persistence of IAA in the plant and promoted the dry matter production. These findings are in agreement with the findings of Krishnamurthy (2005) [12], Mahmoud (2006), Singh *et al.* (2008) [27], Kanaujia *et al.* (2009) [11] and Shaheen *et al.* (2013).

The yield of any crop is the final index of the experiment which indicates the success or failure of any treatment with this view the bulb yield of onion was recorded. The data for the yield plot-1 under different treatments was recorded and converted into total bulb yield q ha-1. Treatment T_{10} (50% RDF + 50% Vermicompost (VC) + 25% *Biofertilizer* (Azotobacter) (4Kg/h) recorded the maximum 256.80q ha-1 total bulb yield. However the lowest 104.98 q ha-1 total bulb yield was noted under controlled conditions. The higher yield might be due to increase in plant height, number of leaves, and yield attributes viz., polar and equatorial diameter of bulb, fresh weight of whole plant, fresh and dry weight of bulb. This might be due to the availability of the nutrients in readily available form and the C: N was high over control. Similar results have been reported by Mahmoud (2006), Bybordi and Malakouti (2007) [3], Patel *et al.* (2008), Mandloi *et al.* (2008) [16], Singh *et al.* (2008) [27], Keniseto Chuda Kanaujia *et al.* (2009) [11] Ethel Ngullie Singh and Singh (2009) [4], Nandal and Bedi (2010) [18], Yoldas *et al.* (2011) [31], Prabhakar *et al.* (2012), Bagali *et al.* (2012) [2], Yeptho *et al.* (2012) [30], Shaheen *et al.* (2013) and Shinde *et al.* (2013) [26].

Marketable bulb yield plot -1 and ha-1 was significantly higher (236.41 q ha-1) under T_{10} while, the minimum (84.82 q ha-1), haulm yield was recorded under treatment control.The higher yield might be due to increase in plant height, number of leaves, and yield attributes viz., polar and equatorial diameter of bulb, fresh weight of whole plant, fresh and dry weight of bulb. This might be due to the availability of the nutrients in readily available form and the C:N was high over control. Similar results have been reported by Mahmoud (2006), Bybordi and Malakouti (2007) [3], Patel *et al.* (2008), Mandloi *et al.* (2008) [16], Singh *et al.* (2008) [27], Kanaujia *et al.* (2009) [11], Ethel Ngullie Singh and Singh (2009) [4], Nandal and Bedi (2010) [18], Yoldas *et al.* (2011) [31].

Table 6: Total bulb yield (q ha-1) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion.

Treat. Symb.	Treatments	Total bulb yield(q/ha)	Marketable yield(q/ha)
T_1	Control	104.98	84.82
T_2	100% Vermicompost	112.22	92.54
T_3	100% Farmyard manure (FYM)	116.48	96.15
T_4	100% RDF	229.19	209.53
T_5	50% RDF + 50% Farmyard manure (FYM)	177.92	157.53
T_6	50% RDF + 50% Vermicompost (VC)	192.21	172.47
T_7	25% RDF + 75% Farmyard manure (FYM)	123.53	103.48
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	242.08	222.91
T_9	25% RDF + 75% Vermicompost (VC)	166.67	146.20
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer*	256.80	236.41

	(Azotobacter) (4Kg/h)		
T_{11}	100% Biofertilizer (Azotobacter)	172.20	146.20
	S. Em.	9.45	12.73
	C.D. 5%	29.10	37.82

Significantly maximum (12.2 %, 11.1 % and 10.9 % and 14.3 %, ºbrix) TSS were observed under the treatment T10 (50% RDF + 50% Vermicompost (VC) + 25% *Biofertilizer* (Azotobacter) (4Kg/h) at 30, 60, 90 DAT and upto harvest Whereas, the lowest TSS % at 30, 60, 90 DAT and harvest respectively (10.3 %, 9.4 %, 9.0 % 12.6 %, ºbrix) was recorded in T_1 (Absolute control).

Table 7: Total soluble solids (ºBrix) as influenced by various fertilizers and azotobacter (*biofertilizer*) in onion.

Treat. Symb.	Treatments	Tss			
		30 dat	60 dat	90 dat	Harvest
T_1	Control	10.3	9.4	9.0	12.6
T_2	100% Vermicompost	10.4	9.5	9.1	12.7
T_3	100% Farmyard manure (FYM)	10.6	9.6	9.2	12.9
T_4	100% RDF	11.3	10.4	9.9	13.7
T_5	50% RDF + 50% Farmyard manure (FYM)	11.1	10.1	9.6	13.4
T_6	50% RDF + 50% Vermicompost (VC)	11.2	10.2	9.7	13.5
T_7	25% RDF + 75% Farmyard manure (FYM)	10.7	9.7	9.3	13.1
T_8	50% RDF + 50% Farmyard manure (FYM)+ *Biofertilizer (Azotobacter) (4Kg/h)*	11.5	10.6	10.1	13.9
T_9	25% RDF + 75% Vermicompost (VC)	10.9	9.9	9.5	13.3
T_{10}	50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)*	12.2	11.1	10.9	14.3
T_{11}	100% Biofertilizer (Azotobacter)	11.02	10.05	9.6	12.26
	S. Em.	0.07	0.07	0.06	0.27
	C.D. 5%	0.23	0.21	0.20	0.27

Conclusion

It can be concluded that plants treated with fertilizers comprising (50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer (Azotobacter) (4Kg/h)* Increased the growth, yield and improved the quality of kharif onion. Hence the application of 50% RDF + 50% Vermicompost (VC) +25% *Biofertilizer* (Azotobacter 4Kg/h) alone proved the most beneficial for growing onion in this region

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