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Influenced of Yield and Economic by effect of Nutrients and Plant Growth Regulators on Onion (*Allium cepa* L.)

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ABSTRACT: A field investigation entitled "Effect of Nutrients and Plant Growth Regulators on Growth, Yield, Quality and Storage Life of Onion (*Allium cepa* L.)" was carried out at Research Farm, RARI, Durgapura (Jaipur, Rajasthan) during *Rabi* season 2016-17 and 2017-18. Results revealed that application of N_4 and G_4 notably higher yield parameters of onion over other treatments. The result also indicated the field curing considerably minimized the neck thickness and increased TSS over poly tunnel curing and curing under 60 % shade net curing. The economics of maximum net returns Rs 475439.31 /ha and Rs 466819.98 /ha were recorded with combined application of NPKSB, mepiquat chloride along with field curing ($N_4G_4C_1$) and NPKSB, mepiquat chloride along with 60% shade net curing ($N_4G_4C_2$) during 2016-17 and 2017-18 respectively. Maximum B: C ratio 6.11 and 6.01 was recorded with combined application of $N_4G_4C_2$ treatment during 2016-17 and 2017-18 respectively.

Keywords: B: C ratio, nutrients onion, yield, plant growth regulators, and net returns.

INTRODUCTION

The onion is a biennial herbaceous, and is typically grown for bulbs as annuals, it belongs to family *Alliaceae*. The onion is a cultivated in almost all the countries of the world and consumed across the globe. Onions are often chopped and used as an ingredient in various healthy warm dishes. Onions are said to be have therapeutic, antibacterial and antifungal beneficial properties. Onion is an indispensable item in every kitchen as vegetable and condiment, therefore commands, an extensive internal market. The flavour and pungency was found due to a volatile oil '*allyl propyl disulphide*' organic compound which rich in sulphur. Onion is most commonly use in pharmaceutical preparations due to its medicinal values and Other than to cure heart diseases as it check the deposition of cholesterol in blood vessels.

Nitrogen is vital for growing plants as it is major essential component of nucleic acid and protein. It is necessary to regulating growth and developmental processes in plant. Nitrogen plays a role as plant hormones. Similarly, Phosphorus is indispensable constituent of nucleic acids, phospholipids and several enzymes. It is also needed for the transfer of energy within the plant system and is involved in its various metabolic activities (Yalwalker *et al*., 1962 and Telalign *et al*., 2012). Potassium important in vigour and disease resistance in plant and plays a significant role in productivity. The indispensable role of K in many physiological and biochemical process in the plants with photosynthesis, enhancing the translocation of assimilate, protein synthesis, maintenance of water balance, and promoting enzyme activities are well establish (Marschner, 2012). Similarly, sulphur is an indispensable component of certain amino acids namely methionine and cysteine and involved in synthesis of proteins and sulphur manner vitamins like biotine, thiamine and various co-enzymes. Sulphur is a ingredient of "Allyl propyl disulphide" which impart the pungency in onion. Boron is essential for normal transport of water, nutrients and photosynthetic sugars to rapidly developing meristemetic tissues, such as root tips, leaves, buds and storage tissues. Boron application can enhance bulb size and yield of onion (Smriti *et al*., 2002). Application of calcium maintains cell turgor, tissue firmness, membrane integrity and delays membrane lipid catabolism of onion (Chaplin and Scott, 1980). Mepiquat chloride have an anti-gibberellin property induce extension in storage life of onion might be due to action (Rahman and Isenberg, 1974). Ethrel played an imperative and essential role in accelerated bulb enlargement, increasing the bulb yield as it and the photosynthetic activity, translocation and accumulation of assimilates resultant in increasing the bulb size. Application of ethylene Inhibition of potato sprouting by continuous has long been known (Rylski *et al.*, 1974; Prange *et al*., 1998). Removing the excess moisture from the external layers of the onion

bulb previous to storage know as curing (Maw *et al.*, 2005). Curing is the most essential operation in the post-harvest processing of onion to immediately after harvest (Nabi *et al*., 2013).

MATERIALS AND METHODS

The experimental research region falls under Agro-Climatic Zone III- A (Semi-Arid Eastern Plain). Durgapura is situated at 26.5º North latitude, 75.47 º East longitudes and 390 meters above Mean Sea Level in Jaipur district of Rajasthan. The preliminary soil fertility condition of experimental plot was well drained clay loam with pH 8.00 and EC 0.80 ds m^{-1}. The presented nitrogen, phosphorus, potassium and sulphur content of the soil were 248.11, 11.14, 168.41 and 13.10 kg per ha, respectively. The experiment was laid out in FRBD with three replication and consisting of Forty-eight treatment combination. The RO-59 variety was sown in nursery beds in November and transplanted in January with 15×10 cm spacing between RXP, respectively. All nutrients like NP@ 100:50 kg per ha (N_1), NPK @100:50:150 kg per ha (N_2), NPKS@100:50:150:45 kg per ha (N_3) and NPKSB@ 100:50:150:45:1kg per ha (N_4) and nutrients and plant growth regulators *viz* like control (G_1), $CaCl_2$@0.5% (G_2), ethephon@3000 ppm (G_3) and mepiquat chloride@750 ppm (G_4) and curing methods *viz.*, field curing (C_1), curing under 60% shade (C_2) and poly tunnel curing (C_3). Application of fertilizers were apply as per treatment by Urea, Di- ammonium phosphate, Murate of potash ,Borax and gypsum at the time of field preparation and remaining half dose of urea apply through top dressing. The growing season of onion applied irrigation at 6-10 days interval. Intercultural operations were followed after 20 days of sowing to weed control and maintain recommended spacing.

Economics

1. Gross Income (Rs) = Total crop production (TCP) x Value of the product (VOP)
2. Total cost (TC) = Common cost (CC) + Treatment cost (TC)
3. Net return (Rs per ha) Net return (Rs per ha) of individual treatment was calculated by deduction of cost of cultivation from the gross return (GR) of particular treatment

Net return (NR) = Gross Return (GR) – Total Cost of Cultivation (TCC).

Benefit: Cost ratio

To find out the B:C Ratio = Net return/ Total Cost of Cultivation In order to evaluate the effect of different treatments on growth, yield and quality attribute, the data were statistically analyze as per .

RESULTS AND DISCUSSION

A. Yield and Yield Parameter

Nutrients effect

Application of N_4 treatment significantly increases ABW (76.26 g), PD (4.99 cm), ED (5.79 cm), TBY (27.77 kg per plot and 425.83 q per ha) and MBY (23.22 kg/plot and 386.36 q/ha). The similar treatment also exhibited minimum neck thickness kg per ha (0.78 cm) of the bulbs (Table 1). The combined application of nutrients might be due to its efficient role in higher net photosynthetic activity and role in carbohydrates translocation from leaves towards bulbs (Black, 1960 and Bidwell, 1979). The increase in yield parameter due to potassium application might be due to its functional role in higher net photosynthetic activity. In addition, it has an indispensable role in translocation of carbohydrates from plant leaves towards bulbs (Black, 1960 and Bidwell, 1979). Application of sulphur Increase bulb yield and better bulb development and thickness of xylem and collenchyma since of higher rate of protein synthesis and improved photosynthetic activity with increased chlorophyll synthesis because of fertilization with sulphur (Biswas *et al.,* 1995). Application of boron improved the enzyme activities which trigger the protein and carbohydrate metabolism in plants. The role of boron in biosynthesis of indole acetic acid and mainly in initiation of primordial for reproductive part and partition of photosynthates towards them, which resulted in better bulb formation and higher yield in onion (Acharya *et al*., 2015). Sharma *et al*. (2018) reported that application of NPKS with Zn significantly increased yield and yield attributes in onion. These results are in consonance with the findings of Kaur *et al.* (2017) and Dixit *et al*. (2018).

Effect of nutrients and plant growth regulators. The production of large sized bulbs with mepiquat chloride might be attributed to the fact that PGR remains physiologically more active to build up sufficient food reserves for developing bulbs, which ultimately leads to increased total bulb yield in garlic (Memane *et al*., 2008). Foliar application of mepiquat chloride @ 750 ppm was recorded significantly higher ABW (73.16 g), PBD (4.70 cm), EBD (5.51 cm), TBY (26.01 kg/plot and 409.01 q/ha) and MBY (22.15 kg/plot and 372.28 q/ha) in onion crop (Table 1). This treatment also exhibited minimum (0.92cm) NT of bulb followed by ethephon @ 3000 ppm (0.95 cm) (Table 1). Pal *et al.* (2017) reported that application of mepiquat chloride @ 125 g/ha *a.i.* 35 DAT obtained maximum bulb diameter and total bulb yield in onion. These results are in accordance with findings of Dimov, (2000) and Sayed *et al.* (2012) in garlic.

Effect of curing. Due to curing treatment, bulbs develop tough skin that limits exchange of gas with the environment. The curing effects shrinks and close the neck in order that oxygen required for shoot growth and emergence of onion bulb is minimize. Curing methods in onion after harvesting affects the thin neck of bulb and neck thickness, protect from atmospheric high temperature and high humidity and ultimately promotes the higher recovery of bulb during storage (Vitnor *et al*., 2017). Curing methods did not exert any significant effect on yield and yield parameter in onion crop. However, minimum neck thickness of bulb (0.94 cm) was recorded with bulbs cured under field followed by poly tunnel curing (0.96 cm) (Table 1).

Table: 1. Effects of nutrients, plant growth regulators and curing on yield and yield attributes in onion.

Treatments	ABW	NT(cm)	PQ(cm)	EQ(cm)	TBY(kg/plot)	TBY(q/ha)	MBY(kg per plot)	MBY(q/ha)
Nutrients (kg/ha)								
N_1	56.58	1.08	3.74	4.28	19.84	317.37	16.46	271.80
N_2	69.45	1.02	4.45	5.14	24.14	382.79	20.16	333.31
N_3	73.96	0.96	4.83	5.62	26.52	408.61	22.39	373.93
N_4	**76.26**	0.78	4.99	5.79	27.77	425.83	23.22	386.36
SEm+	**0.77**	**0.01**	**0.05**	**0.06**	**0.34**	**4.47**	**0.24**	**4.35**
CD (P=0.05)	**2.16**	**0.03**	**0.15**	**0.16**	**0.95**	**12.46**	**0.67**	**12.13**
Nutrient and plant growth regulators								
G_1	64.50	1.00	4.35	4.91	22.96	353.95	18.62	306.11
G_2	67.62	0.97	4.42	5.12	24.04	375.75	20.01	327.09
G_3	70.98	0.95	4.54	5.30	25.27	395.89	21.46	359.92
G_4	**73.16**	0.92	4.70	5.51	26.01	409.01	22.15	372.28
SEm+	**0.77**	**0.01**	**0.05**	**0.06**	**0.34**	**4.47**	**0.24**	**4.35**
CD (P=0.05)	**2.16**	**0.03**	**0.15**	**0.16**	**0.95**	**12.46**	**0.67**	**12.13**
Curing								
C_1	68.92	0.94	4.49	5.18	24.59	381.56	20.49	340.02
C_2	69.65	0.99	4.54	5.28	24.70	390.01	20.77	346.65
C_3	68.62	0.96	4.47	5.17	24.42	379.38	20.42	337.39
SEm+	**0.67**	**0.01**	**0.05**	**0.05**	**0.30**	**3.87**	**0.21**	**3.77**
CD (P=0.05)	**NS**	**0.03**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

ABW= Average bulb weight, NT= Neck thickness, PD= Polar diameter, EQ= Equatorial diameter, TBY= Total bulb yield, MBY= Marketable bulb yield, NS -Non- significant

B. Economic

Net Returns. Interactive effect between nutrients, plant growth regulator and curing method ware found to be significant with respect to net returns (Table 2). Results indicated that economics of maximum net returns Rs 475439.31/ha and Rs 466819.98/ha were recorded with combined application of NPKSB, mepiquat chloride along with field curing ($N_4G_4C_1$) and NPKSB, mepiquat chloride along with 60% shade net curing ($N_4G_4C_2$) during 2016-17 and 2017-18 respectively.

Table 2: Common cost of cultivation for one hectare of the experiment.

Sr. No.	Particulars	Units	Rate per unit (Rs)	Cost (Rs per ha)
(A)	Tractor charges for Land preparation (4 ploughing and 01 planking)	12hrs	370	4440
(B)	Field preparation			
	Bed preparation	20 labour	245	4900
	Planting of seedling	33 labour	245	8085
	Irrigation	17 labour	245	4165
	Weeding and hoeing	16 labour	245	3920
	Spraying of fungicides/ insecticides/Pant growth regulators	6 labour	245	1470
	Spraying of Pant growth regulators	8 labour	245	1960
	Fertilizers and manuring application	7 labour	245	1715
	Harvesting /preparation of produce	30 labour	245	7350
	Miscellaneous			1000
	Total			34565
(c)	Material inputs			
	Seed material	10kg/ha	1600	16000
	Plant protection			3000
	Electricity charges			2000
	Total			22000
(D)	Overhead cost			
	Land rental value			4711
	Working capital interest			3974
	Depreciation cost			1000
	Total			9685
(E)	Storage work			
	Curing	18 labour	245	4410
	Storage	20 labour	245	4900
	Total			9310

General cost of cultivation = I(A) + I(B) + I(C) + (D)+ (E)= Rs 80000/-

Table 3: Comparative economics of various treatments of onion (2016-17&2017-18).

Treatment combinations (2016-17 & 17-18)	Common cost of cultivation (Rs/ha) (2016-17 & 17-18)	Treatment cost (Rs ha^{-1}) (2016-17 & 17-18)	Total cost of cultivation (Rs ha^{-1}) (2016-17 & 17-18)	Bulb yield (q ha^{-1}) 2016-17	Bulb yield (q ha^{-1}) 2017-18	Gross returns (Rs ha^{-1}) 2016-17	Gross returns (Rs ha^{-1}) 2017-18	Net returns (Rs ha^{-1}2016-17	Net returns (Rs ha^{-1}) 2017-18	B : C ratio 2016-17	B : C ratio 2017-18
$N_1G_1C_1$	80000	6719.70	86719.70	207.33	204.66	290262.00	286528.67	203542.30	199808.96	3.35	3.30
$N_1G_1C_2$	80000	6719.70	86719.70	214.98	214.76	300966.87	300663.02	214247.16	213943.32	3.47	3.47
$N_1G_1C_3$	80000	6719.70	86719.70	201.55	189.20	282165.15	264881.87	195445.44	178162.16	3.25	3.05
$N_1G_2C_1$	80000	6744.70	86744.70	205.93	210.95	288308.53	295327.20	201563.83	208582.50	3.32	3.40
$N_1G_2C_2$	80000	6744.70	86744.70	210.32	212.32	294446.13	297252.67	207701.43	210507.96	3.39	3.43
$N_1G_2C_3$	80000	6744.70	86744.70	218.62	213.26	306063.33	298564.00	219318.63	211819.30	3.53	3.44
$N_1G_3C_1$	80000	7844.70	87844.70	229.32	256.14	321048.00	358591.33	233203.30	270746.63	3.65	4.08
$N_1G_3C_2$	80000	7844.70	87844.70	262.82	262.32	367948.00	367243.33	280103.30	279398.63	4.19	4.18
$N_1G_3C_3$	80000	7844.70	87844.70	229.02	256.28	320625.67	358792.00	232780.96	270947.30	3.65	4.08
$N_1G_4C_1$	80000	6832.20	86832.20	250.11	253.43	350158.67	354806.67	263326.46	267974.46	4.03	4.09
$N_1G_4C_2$	80000	6832.20	86832.20	266.54	280.65	373160.67	392910.00	286328.46	306077.80	4.30	4.52
$N_1G_4C_3$	80000	6832.20	86832.20	248.14	260.22	347392.73	364301.47	260560.53	277469.26	4.00	4.20
$N_2G_1C_1$	80000	9839.70	89839.70	232.36	248.65	325308.67	348105.33	235468.96	258265.63	3.62	3.87
$N_2G_1C_2$	80000	9839.70	89839.70	247.21	267.77	346089.33	374882.67	256249.63	285042.96	3.85	4.17
$N_2G_1C_3$	80000	9839.70	89839.70	237.90	236.89	333060.00	331641.33	243220.30	241801.63	3.71	3.69
$N_2G_2C_1$	80000	9864.70	89864.70	244.52	271.88	342328.00	380632.00	252463.30	290767.30	3.81	4.24
$N_2G_2C_2$	80000	9864.70	89864.70	283.26	293.05	396568.67	410265.33	306703.96	320400.63	4.41	4.57
$N_2G_2C_3$	80000	9864.70	89864.70	273.04	284.45	382257.87	398225.33	292393.16	308360.63	4.25	4.43
$N_2G_3C_1$	80000	10964.70	90964.70	312.51	313.73	437509.33	439226.67	346544.63	348261.96	4.81	4.83
$N_2G_3C_2$	80000	10964.70	90964.70	319.25	338.47	446950.00	473853.33	355985.30	382888.63	4.91	5.21
$N_2G_3C_3$	80000	10964.70	90964.70	306.11	318.80	428549.33	446320.00	337584.63	355355.30	4.71	4.91
$N_2G_4C_1$	80000	9952.20	89952.20	318.92	330.00	446488.00	462000.00	356535.80	372047.80	4.96	5.14
$N_2G_4C_2$	80000	9952.20	89952.20	333.17	338.60	466433.33	474040.00	376481.13	384087.80	5.19	5.27
$N_2G_4C_3$	80000	9952.20	89952.20	314.73	328.57	440626.67	460002.67	350674.46	370050.46	4.90	5.11
$N_3G_1C_1$	80000	10062.68	90062.68	268.09	287.51	375330.67	402518.67	285267.99	312455.99	4.17	4.47
$N_3G_1C_2$	80000	10062.68	90062.68	295.80	311.47	414120.00	436053.33	324057.32	345990.66	4.60	4.84
$N_3G_1C_3$	80000	10062.68	90062.68	285.47	298.09	399653.33	417330.67	309590.66	327267.99	4.44	4.63
$N_3G_2C_1$	80000	10087.68	90087.68	287.27	300.93	402173.33	421306.67	312085.66	331218.99	4.46	4.68
$N_3G_2C_2$	80000	10087.68	90087.68	309.21	312.38	432896.80	437336.67	342809.12	347248.99	4.81	4.85
$N_3G_2C_3$	80000	10087.68	90087.68	324.44	316.07	454221.60	442493.33	364133.92	352405.66	5.04	4.91
$N_3G_3C_1$	80000	11187.68	91187.68	334.73	323.93	468626.67	453506.67	377438.99	362318.99	5.14	4.97
$N_3G_3C_2$	80000	11187.68	91187.68	342.93	357.52	480106.67	500528.00	388918.99	409340.32	5.27	5.49
$N_3G_3C_3$	80000	11187.68	91187.68	333.20	352.80	466480.00	493920.00	375292.32	402732.32	5.12	5.42
$N_3G_4C_1$	80000	10175.18	90175.18	341.53	352.77	478142.00	493873.33	387966.82	403698.16	5.30	5.48
$N_3G_4C_2$	80000	10175.18	90175.18	347.70	367.79	486777.20	514901.33	396602.02	424726.16	5.40	5.71
$N_3G_4C_3$	80000	10175.18	90175.18	334.67	350.07	468533.33	490102.67	378358.16	399927.49	5.20	5.44
$N_4G_1C_1$	80000	12880.86	92880.86	271.95	289.09	380734.67	404726.00	287853.81	311845.14	4.10	4.36
$N_4G_1C_2$	80000	12880.86	92880.86	260.38	292.92	364536.67	410083.33	271655.81	317202.48	3.92	4.42
$N_4G_1C_3$	80000	12880.86	92880.86	241.69	282.77	338370.67	395882.67	245489.81	303001.81	3.64	4.26
$N_4G_2C_1$	80000	12905.86	92905.86	345.61	332.98	483854.00	466176.67	390948.14	373270.81	5.21	5.02
$N_4G_2C_2$	80000	12905.86	92905.86	353.74	343.29	495236.00	480606.00	402330.14	387700.14	5.33	5.17
$N_4G_2C_3$	80000	12905.86	92905.86	322.53	324.12	451542.00	453763.33	358636.14	360857.48	4.86	4.88
$N_4G_3C_1$	80000	14005.86	94005.86	373.88	374.64	523432.00	524496.00	429426.14	430490.14	5.57	5.58
$N_4G_3C_2$	80000	14005.86	94005.86	374.57	381.51	524402.67	534118.67	430396.81	440112.81	5.58	5.68
$N_4G_3C_3$	80000	14005.86	94005.86	359.57	377.95	503402.67	529130.00	409396.81	435124.14	5.36	5.63
$N_4G_4C_1$	80000	12993.36	92993.36	392.75	399.87	549854.67	559813.33	456861.31	466819.98	5.91	6.02
$N_4G_4C_2$	80000	12993.36	92993.36	406.02	399.35	568432.67	559090.00	475439.31	466096.64	6.11	6.01
$N_4G_4C_3$	80000	12993.36	92993.36	387.06	389.70	541884.00	545575.33	448890.64	452581.98	5.83	5.87

Sale price of bulb = ₹ 14/kg, Urea= ₹ 6.2/kg, DAP = ₹ 24.40/ kg ; MOP = ₹ 12.48/kg, Gypsum = ₹ 0.92/kg, Borax = ₹ 310/kg; $CaCl_2$ = ₹10/kg, Ethephon = ₹ 750/L, Mepiquat Chloride = ₹ 300/L

The adequate supply of the phosphorus and potassium to the crop should be emphasizing for strengthening of the root system and suitable establishment of the onion crop. The use of plant growth regulators can prove propitious in managing physiological efficiency including photosynthetic ability and can improve the effective partitioning of accumulates from source to sink in the crops. Sayed *et al.* (2012) reveals that combined application of mepiquat chloride @ 500 ppm with 96 kg K_2O/fed significantly increased total yield of bulb and net returns in garlic crop. These outcome are in accordance of agreed with those of Das *et al*., (1996); Dimov (2000) in garlic crop.

B: C Ratio. Interactive effect between nutrients, plant growth regulators along with curing methods have significant effect on Benefit: Cost ratio (Table 2). The maximum Benefit: Cost ratio (6.11 & 6.01) was recorded with combined application of NPKSB, mepiquat chloride along with 60% shade net curing ($N_4G_4C_2$) during both of the year respectively than other treatment combinations. On the other hand, application of NP, control along with poly tunnel curing methods gave minimum B: C ratio (3.25 & 3.05) during both of the year respectively. On the source of the research as well as economic point of views, an application of nutrients, plant growth regulators along with curing methods produced its significant impact on net returns and B:C ratio. The ($N_4G_4C_2$) treatments were found economical, cost-effective and proved highly remunerative conditions for growing the onion cv. 'RO 59 under the Durgapura (Rajasthan, India).

CONCLUSION

Based on the results, it is concluded that application of N_4G_4 (N_{100}: P_{50}: K_{150}: S_{45}: B_1 + mepiquat chloride @ 750 ppm) was considered as the best treatment in respect to obtain significantly higher total bulb yield (465.56 q/ha) as well as marketable bulb yield (435 q/ha) in onion crop. This treatment also gave significantly higher net returns (₹ 461114.98/ha) and B: C ratio (5.96:1).

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