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Effect of crop geometry and fertility levels on growth, yield and quality of kharif onion in semi-arid conditions

A.K. Soni and S. Pareek*
Department of Horticulture, SKN College of Agriculture, Jobner-303 328

Abstract

A field experiment to study the effect of crop geometry and fertility levels on growth, yield and quality of kharif onion was conducted at Horticulture Farm, SKN College of Agriculture, Jobner during kharif seasons of 2001 and 2002. Plant spacing 45cm x 10 cm was superior over different spacing in relation to growth (number of leaves plant^{-1}, fresh and dry weight of leaves), yield attributes (neck thickness, neck length, equatorial diameter, polar diameter, number of scales bulb^{-1}, fresh weight and volume of bulb) and quality attributes (N, P and K in bulb). Yield of bulbs was maximum at 30 cm x 10 cm spacing. Fifty per cent recommended dose of NPK + vermicompost 2.5 t ha^{-1} significantly improved the growth, yield and quality attributes (pungency and vitamin C) over rest of the treatments.

Key words: *Onion, spacing, fertility levels, growth, yield, quality*

Introduction

Onion (*Allium cepa* L.) is one of the important bulb and cash crop. India ranks second in onion production, which shares 5 per cent of total vegetable production (Anonymous, 2005). Generally, onion is cultivated in rabi season but early kharif and late kharif crops are also taken in various states. During October-November, there is shortage of onion in the market, which leads to high price. Therefore, production of onion in kharif season is more important to have continuous supply of onion round the year. However, in Rajasthan, kharif onion is cultivated in very less area due to the lack of suitable production technology. The optimization of crop geometry is an important factor, which has direct influence on growth, bulb yield and quality. Integrated nutrient supply system for the crop by judicious mixture of organic manure along with the inorganic fertilizer has a number of agronomic and environmental efficiencies. The information on the balance use of chemical fertilizers along with vermicompost for kharif season onion in arid and semi-arid regions is very scarce. Hence, keeping these facts in view an investigation on effect of crop geometry and fertility levels on growth, yield and quality of kharif onion (cv. N-53) in semi-arid conditions was conducted.

***Corresponding author's E-mail:**
sunil_ciah@yahoo.co.in

Materials and methods

The experiment was conducted using N-53 cultivar of onion at the Horticulture Research Farm, SKN College of Agriculture, Jobner. Experiment was conducted for two consecutive years in kharif season of 2001 and 2002. The soil of the expermental site was loamy sand (85.2% sand, 9.2% silt and 5.4% clay), pH of 8.0, electrical conductivity of 1.20 dS m^{-1}, available carbon, 0.16%, and available N, P_2O_5 and K_2O of 130, 15.20 and 140 kg ha^{-1}, respectively.

The experiment comprised of 32 combinations of four spacing and eight levels of fertilizers related to recommended dose along with vermicompost. The spacing treatment consisted of 30 cm x10 cm (S_1), 30 cm x 5 cm (S_2), 45 cm x 10 cm (S_3) and 45 cm x 15 cm (S_4). Fertility levels used were no fertilizer (T_1), 75 per cent of recommended dose of NPK (T_2), 100 per cent of recommended dose of NPK (T_3), 125 per cent of recommended dose of NPK (T_4), vermicompost @ 2.5 t ha^{-1} (T_5), 25 per cent of recommended dose of NPK + 2.5 t ha^{-1} vermicompost (T_6), 50 per cent of recommended dose of NPK + 2.5 t ha^{-1} vermicompost (T_7), and 75 per cent of recommended dose of NPK + 2.5 t ha^{-1} vermicompost (T_8). The experiment was laid out in split plot design with spacing in main plot and fertility levels in subplots, having 4 replication.

The recommended dose of NPK for onion crop was 100 : 50 : 100 kg ha^{-1}. The application of urea was given in two split doses, first at the time of planting and remaining half dose 40 days after planting. Single super phosphate and Murate of Potash were applied as basal dose. The

Table 1. Effect of spacing and fertility level in growth, yield and yield attributes of onion cv. N-53 (Pooled of 2 years)

Treatment	Plant height (cm)	No. of leaves plant^{-1} at harvest	Fresh weight of leaves at harvest	Dry weight of leaves at harvest	Neck thickness (cm)	Neck length (cm)	Equatorial diameter (cm)	Polar diameter (cm)	No. of scales bulb^{-1}	Thickness of scale (cm)	Fresh weight of bulb	Volume of bulb (cc)	Bulb yield (q ha^{-1})
Spacing													
S_1	50.97	9.95	45.40	5.67	0.82	5.87	4.92	4.64	6.23	0.231	77.41	49.65	257.96
S_2	50.92	10.00	48.47	5.70	0.86	6.04	5.18	4.64	6.20	0.242	77.82	51.10	172.97
S_3	51.15	10.56	52.69	6.02	0.89	6.16	5.24	4.84	6.46	0.235	79.09	52.98	174.64
S_4	51.07	10.61	49.16	5.92	0.91	6.31	5.28	4.81	6.35	0.244	80.32	53.09	115.65
C D at 5%	NS	0.359	1.153	0.179	0.023	0.185	0.121	0.114	0.127	0.006	1.340	1.572	7.562
Fertility levels													
T_1	38.42	6.61	32.68	3.89	0.62	5.73	4.07	3.59	4.74	0.188	56.59	41.63	128.76
T_2	52.29	9.80	48.32	5.52	0.67	5.81	4.80	4.65	4.85	0.212	69.27	48.05	158.51
T_3	52.96	10.67	51.19	6.10	0.72	5.94	5.34	4.83	6.57	0.248	79.53	53.74	182.03
T_4	52.82	10.36	48.77	5.81	0.81	6.08	5.25	4.74	6.26	0.229	76.39	53.50	174.97
T_5	52.47	10.08	47.90	5.71	0.93	6.21	5.15	4.69	6.14	0.221	71.11	51.18	161.27
T_6	52.99	11.17	52.51	6.26	1.02	6.28	5.43	4.97	6.79	0.263	86.48	54.37	198.10
T_7	53.11	11.91	56.92	6.78	1.07	6.32	5.62	5.25	7.17	0.274	94.78	56.03	224.29
T_8	53.16	11.63	55.13	6.57	1.11	6.40	5.60	5.15	6.95	0.272	95.14	55.15	214.54
C D at 5%	1.832	0.338	1.199	0.186	0.030	0.187	0.153	0.143	0.163	0.007	1.230	1.860	7.301

N.S.= not significant

vermicompost contained 2.5 per cent N, 1.5 per cent P_2O_5, and 1.5 per cent K_2O. All the other cultural operations were carried out as per recommended package of practices for onion crop.

The observation on various traits like plant height, number of leaves per plant, fresh weight of leaves at harvest, dry weight of leaves, neck thickness, neck length, equatorial diameter, polar diameter, number of scales bulb^{-1}, thickness of scales, fresh weight of bulb, volume of bulb and bulb yield were recorded. Among quality attributes TSS, vitamin C, N, P, K and S contents of bulb and allyl propyl disulphide (pungency) content in bulbs were analysed.

Results and discussion

Growth attributes

Plant spacing had non-significant effect on plant height whereas, significantly higher number of leaves and more fresh and dry weight of leaves at harvest were noticed with the wider plant spacing i.e., 45 cm x 10 cm and 45 cm x 15 cm whereas S_3 and S_4 were at par. This might be due to the fact that wider plant spacing caused lesser competition for space, nutrients and light. Significantly more plant height, number of leaves per plant, fresh and dry weight of leaves per plant at harvest were recorded with 50 per cent recommended dose of NPK along with vermicompost 2.5 t ha^{-1} (Table1). However, it was statistically at par with 75 per cent recommended dose of NPK along with 2.5 tha^{-1} vermicompost (T_8). The improvement in growth parameters with the application of vermicompost and NPK might be due to better water holding capacity and supply and availability of major and micronutrients due to favourable soil condition (Reddy *et al.*, 1998). The present trend of increase is supported by the findings of Rizk (1997) in onion.

Yield attributes and Yield

Neck thickness, neck length, equatorial diameter, polar diameter, number of scales bulb^{-1}, thickness of scales, fresh weight of bulb and volume of bulb increased with the wider plant spacing of 45 cm x 15 cm or 45 cm x 10 cm (Table1). This might be due to the lesser number of plants in a given area causing lesser competition for nutrient, increasing food assimilatory efficiency and thereby deposited more food in bulbs. However, maximum bulb yield was recorded in closer spacing (30 cm x 10 cm), whereas minimum in wider spacing (45 cm x 15 cm). This was due to lesser number of bulbs accommodated in wider spacing. Increased yield of onion due to closer spacing had also been recorded by Yadav *et al.* (2002). The significant improvement in yield attributes of onion was recorded with 50 per cent recommended dose of NPK along with 2.5 t ha^{-1} vermicompost (Table 1). This treatment also resulted into increased yield by 74.19 per cent over control and by 39.07 per cent over the vermicompost alone (T_5). The present trends of increase in yield and yield attributes are in close conformity with the findings of Patil *et al.* (2002) in onion.

Interaction effects of plant geometry and fertility levels

The interaction effect of spacing and fertility level was found significant for equatorial diameter, fresh weight of bulb and bulb yield. Maximum values for equatorial diameter and fresh weight of bulb were observed when 50 per cent recommended dose of NPK (50:25:50 kg NPK ha^{-1}) along with vermicompost 2.5 t ha^{-1} (T_7) was applied in conjunction with the spacing of 45 x 10 cm (S_3). However, the maximum bulb yield (Table 2) was observed in the

Table 2. Interaction effect of plant spacing x fertility levelon bulb yield (q ha^{-1}) of onion (Pooled of 2 years)

	S_1	S_2	S_3	S_4	Mean
T_1	184.03	123.85	124.55	82.62	128.76
T_2	227.91	153.18	152.04	100.91	158.51
T_3	260.53	173.76	177.02	116.82	182.03
T_4	250.46	168.07	169.22	112.12	174.97
T_5	228.88	155.62	156.64	103.93	161.27
T_6	284.20	189.40	191.73	127.10	198.10
T_7	323.96	215.93	220.91	136.39	224.29
T_8	303.75	204.00	205.06	145.36	214.54
Mean	257.96	172.97	174.64	115.65	
			C D at 5%		
S same, T different			14.601		
S different, T same			18.089		

treatment combination S_1T_7. Although, both fertility levels and plant spacing independently brought significant variation in yield attributes but interaction of S_1 x T_7 showed that response of fertility level was governed by plant spacing and vice-versa. These findings corroborate with the findings of Sharma *et al.* (2003).

Quality attributes

It was observed that plant spacing had non-significant effect on TSS, sulphur content, allyl-propyl-disulphide and ascorbic acid content. Similar results were also reported by Naik and Hosamani (2000) in onion. Whereas, significant increase in N, P and K contents in bulb with wider plant spacing i.e., 45 cm x 10 cm and 45 cm x 15 cm was noticed (Table 3). Wider spacing, increased availability of nutrients, light and moisture to plant coupled with increased metabolic activity at the cellular level might have increased the nutrient uptake and accumulation in the vegetative plant parts, improved metabolism led to greater translocation of these nutrients to repository organ (bulb) of the crop. Significant increase in quality attributes with wider spacing was earlier reported by Jha *et al.* (2000). Increase in fertility levels up to 50 per cent recommended dose of NPK along with vermicompost 2.5 t ha^{-1} increased NPK content and allyl-propyl-disulphide of bulb (Table 3). Sharma *et al.* (2003) also reported the same results.

Economic feasibility

The economics of various treatment combinations with benefit:cost ratio are given in table 4. The data revealed

Table 3. Effect of spacing and fertility levels on quality attributes of onion cv. N-53 (Pooled of 2 years)

Treatments	TSS (%)	S content (%)	Allyl propyl disulphide	Ascorbic acid (mg 100g^{-1})	N content (%)	P content (%)	K content (%)
Spacing							
S_1	12.18	0.666	6.82	9.42	0.760	0.339	1.09
S_2	12.20	0.669	6.86	9.46	0.768	0.343	1.09
S_3	12.22	0.677	6.94	9.53	0.786	0.357	1.12
S_4	12.23	0.675	6.89	9.47	0.777	0.351	1.12
C D at 5%	NS	NS	NS	NS	0.011	0.007	0.175
Fertility levels							
T_1	12.04	0.637	6.57	9.20	0.539	0.263	1.08
T_2	12.09	0.658	6.67	9.23	0.754	0.280	1.09
T_3	12.15	0.678	6.95	9.58	0.801	0.343	1.12
T_4	12.20	0.672	6.81	9.44	0.794	0.315	1.10
T_5	12.22	0.666	6.74	9.36	0.785	0.295	1.09
T_6	12.27	0.684	7.01	9.62	0.814	0.380	1.12
T_7	12.32	0.692	7.23	9.66	0.846	0.474	1.12
T_8	12.36	0.688	7.07	9.68	0.853	0.430	1.12
C D at 5%	0.232	0.011	0.187	0.188	0.012	0.009	0.016

N.S. = not significant.

Table 4. Comparative economics of various treatments

Treatment combinations	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Treatment cost (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
S_1T_1	184.03	21400	5800	27200	101217	74817	2.75:1
S_1T_2	227.91	21400	7500	28900	125351	96451	3.34:1
S_1T_3	260.53	21400	8105	29505	143291	113786	3.86:1
S_1T_4	250.46	21400	8683	30083	137753	107670	3.58:1
S_1T_5	228.88	21400	10800	32200	125884	93684	2.90:1
S_1T_6	284.20	21400	11342	32742	156310	123568	3.77:1
S_1T_7	323.96	21400	11953	33353	178178	144825	4.34:1
S_1T_8	303.75	21400	12530	33930	167063	133133	3.92:1
S_2T_1	123.85	21400	5300	26700	68118	41418	1.55:1
S_2T_2	153.18	21400	7030	28430	107226	78796	2.77:1
S_2T_3	173.76	21400	7605	29005	121632	92627	3.19:1
S_2T_4	168.07	21400	8183	29583	117649	88066	2.97:1
S_2T_5	155.62	21400	10300	31700	108934	77234	2.44:1
S_2T_6	189.40	21400	10842	32242	132580	100338	3.11:1
S_2T_7	215.93	21400	11453	32853	151151	118298	3.60:1
S_2T_8	204.00	21400	12030	33430	142800	109370	3.27:1
S_3T_1	124.55	21400	5300	26700	68503	41803	1.56:1
S_3T_2	152.04	21400	7030	28430	106428	77998	2.74:1
S_3T_3	177.02	21400	7605	29005	150467	121462	4.18:1
S_3T_4	168.22	21400	8183	29583	142987	113404	3.83:1
S_3T_5	156.64	21400	10300	31700	133144	101444	3.26:1
S_3T_6	191.73	21400	10842	32242	162971	130729	4.05:1
S_3T_7	220.91	21400	11453	32853	187774	154921	4.71:1
S_3T_8	205.06	21400	12030	33430	174301	140871	4.21:1
S_4T_1	82.62	21400	4755	26155	57834	31679	1.21:1
S_4T_2	100.91	21400	6485	27885	70637	42752	1.53:1
S_4T_3	116.82	21400	7060	28460	99297	70837	2.48:1
S_4T_4	112.12	21400	7638	29038	78484	49446	1.70:1
S_4T_5	103.93	21400	9755	31155	88341	57186	1.83:1
S_4T_6	127.10	21400	10297	31697	108035	76338	2.40:1
S_4T_7	136.39	21400	10908	32308	115932	83624	2.59:1
S_4T_8	145.36	21400	11485	32885	123556	90671	2.75:1

that the maximum net profit of Rs. 15,492,1.0 ha^{-1} was obtained under the treatment combination S_3T_7 followed by S_1T_7 with a profit of Rs. 14,482,5.0 ha^{-1}. The minimum net profit of Rs. 31,679.0 ha^{-1} was gained under the treatment combination S_4T_1. Data presented in same table further revealed that S_3T_7 treatment combination resulted in the highest B:C ratio of 4.71:1 followed by S_1T_7 whereas, the minimum B:C ratio (1.21:1) was obtained under the treatment combination S_4T_1. Therefore, it could be inferred from findings that S_3T_7 was most economical combination.

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