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Effect of Different Levels of Nitrogen and Methods of Application on Growth and Yield of Garlic (*Allium sativum* L.)

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A B S T R A C T

Field experiment was carried out from 2013– 14 to 2015– 16 at S. D. Agricultural University, Sardarkrushinagar to standardize the dose of nitrogen and its method of application in garlic under semi arid region of Gujarat. Twelve treatments comprising various combinations of nitrogen (75, 100, 125, 150, 175 and 200 kg N/ha) and methods of application (50% N_2 as a basal application & 50% as in two split at 45 and 75 days of sowing and second level as 20% N_2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing) were evaluated for growth and yield parameters of garlic. Growth and yield parameters were significantly improved by 125 kg nitrogen per hectare when applied through 20 per cent as basal and remaining 80 per cent as top dressing in four split at 30,50,70,90 days after sowing.

Introduction

India ranks second in garlic production in world and among Indian states Gujarat ranks second in area and production with 35.0 m ha area and 250.0 m t production. India is also a major exporter of garlic bulb, dehydrated garlic, garlic powder and garlic oil etc. Indian garlic is now exported even to Pakistan, Thailand and Malaysia, as well as the traditional market of Bangladesh.

Though the average productivity of garlic in state i.e. 7.14 t/ ha is above national average i.e. 5.43 t/ ha. But still it is far behind the average yield of Punjab (12.16 t/ ha), West Bengal (11.94 t/ ha) and Maharashtra (11.43 t/ ha) (Anon, 2015). This yield gap might be due to several reasons viz. availability of improved cultivars, soil type, nutrition management, irrigation availability, plant protection measures etc. but among them nutrition plays an important role. The area of North Gujarat is characterized by semi arid and soil type is loamy sand. NPK requirement is different via state wise like Arunachal Pradesh-125:60:100, Assam-50:60:100, Goa-10:70:100, Haryana-80:50:25.

Till now the growers are following the ad-hoc recommendation of nutrition application of 100-50-50 NPK in which 50-50-50 NPK as basal and remaining 50 kg nitrogen in two equal splits at 30 and 50 days after planting but it was felt that as garlic is a long duration crop and soil type is sandy hence more splits of nitrogen can be more effective for yield. Further the dose should also be standardized which may be lower or higher then ad-hoc. In sandy soil, leaching rate of nitrogen is high as compare to clay type of soil. Fertilizer requirement of any crop varies with the soil condition and the soil of North Gujarat is sandy with poor organic Carbon and water holding capacity. In such situation application of Nitrogen to its maximum efficiency is a challenge.

Keeping this in view the present experiment was planned and executed to enhance the garlic productivity.

Materials and Methods

The experiment was carried out during rabi season for three consecutive years i.e. 2013 – 14, 2014 – 15 and 2015 – 16 at Horticulture Instructional Farm, Department of Horticulture, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushi-nagar. The soil of experimental field was sandy loam textural class having pH and electrical conductivity 7.8 and 0.18 dSm-1 respectively. The fertility status of the experimental field was found to be low in organic carbon (0.16 %), low in organic carbon (0.21%), medium in available phosphorus (37.11 kg ha-1) and available potash (287 kg ha-1). Except treatment application of nitrogen, all the cultural practices were uniformly followed to raise the crop. The cloves were planted at a spacing of 15 cm X 7.5 cm in plot of 3.0 m X 1.50 m. Irrigation was applied through micro sprinklers.

The variety selected for the study was Agrifound White (G – 41) was procured from NHRDF, Nasik during first year. Experiment was statistically laid out in Factorial Randomized Block Design which consisted of two factors viz. Nitrogen with six levels (75, 100, 125, 150, 175 and 200 kg N/ha) and methods of application with two levels (50% N_2 as a basal application & 50% as in two split at 45 and 75 days of sowing and second level as 20% N_2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing), thus making total 12 treatment combinations. Experiment was replicated thrice.

Treatments were evaluated for growth (Plant height (cm) at 90 Days after planting, Number of leaves per plant, Days taken for bulb maturity, Neck thickness (cm) at harvesting) and yield and yield attributes (Diameter of bulb (cm), Weight of bulb (g), Number of cloves per bulb and Yield kg/plotand q/ha).

Plant height was measured with measuring scale while leaves numbers, days taken for bulb maturity from planting to harvesting were counted. Neck thickness and diameter of bulb was measured with digital verniarcalliper (CD-6" CSX, Mitutoya). Yield per plot was weighed after harvesting and curing which was converted in to per hectare basis. Weight of bulb was taken on digital balance. Number of cloves per bulb was also counted to record the data.

Ten plants from each net plot were tagged to record the data. The recorded data were subjected to statistical analysis using the analysis of variance technique (Gomez and Gomez, 1984).

Results and Discussion

Effect of nitrogen

Data present in tables revealed that growth,

yield and quality of garlic cultivar Agrifound White was significantly influenced by dose of nitrogen. Perusal of table showed that plant height at 90 days after planting was significantly maximum by application of 125 kg nitrogen per hectare on pooled data basis. Though it was non-significantly differed with 100, 150, 175 and 200 kg N/ha application. On pooled data basis maximum number of leaves per plant of 8.14 was recorded under treatment 150 kg/ha which was non-significant followed by 125, 175 and 200 kg N/ha treatment. Nitrogen increased the rates of leaf initiation and extension of garlic in early growth (Koltunov, 1984). This might be because of nitrogen is being an essential constituent of chlorophyll, protoplasm and enzymes and as it governs utilization of P and K. Similar results were also obtained by Yadav *et al.,* (2007) and Thakur (2011).

Pooled analysis of data indicate that significantly maximum neck thickness of 6.85 cm at harvesting was observed in N_2 treatment i.e. 100 kg N/ha which was at par with 125, 150 and 175 kg N/ha. Maximum diameter and weight of bulb (3.44 cm and 24.15 g, respectively) was recorded with application of 125 kg N/ha. Diameter of bulb was statistically at par in N_2, N_4, N_5 and N_6 treatments. Whereas, bulb weight in treatment N_4, N_5 and N_6.

Maximum number of cloves per bulb of 18.64 were recorded with treatment of 175 kg N/ha, though it was non-significantly followed by 125, 150 and 200 kg N/ha treatment.

Significantly maximum yield of 4.35 kg per plot and 124.05 q/ha was recorded with application of 125 kg N/ha and though yield (Per plot and per hectare) was non-significantly differed with application of 150 kg N/ha. This might be due to more availability of nitrogen to plant frequent application of nitrogen. Results of Reddy *et al.,* (2000) and Yadav (2003) are in accordance with above results.

Pooled analysis of data indicate that significantly maximum neck thickness of 6.85 cm at harvesting was observed in N_2 treatment *i.e.*100 kg N/ha which was at par with 125, 150 and 175 kg N/ha. Maximum diameter and weight of bulb (3.44 cm and 24.15 g, respectively) was recorded with the application of 125 kg N/ha.

Diameter was statistically at par in N_2, N_4, N_5 and N_6 treatments whereas bulb weight in N_4, N_5 and N_6.These findings were also reported by Panchal (1989) and Patel (1993). Cassman *et al.,* (2002) Imbalanced and poorly monitored nitrogen application limits yields and induces large losses of reactive nitrogen to the environment.

Effect of method of application

Perusal of data clearly shows that method of application of nitrogen could not brought significant effect on various growth, yield and quality attributes of garlic except days taken for bulb maturity. Application of nitrogen as 20 % basal and remaining of 80 % as top dressing in four splits was able to reduce the crop period by about 4 days which was significantly superior over 50 % nitrogen as basal and remaining 50 % as two split.

Interaction effect

None of the interaction could statistically significantly influence the any of the parameter except plant height and neck thickness.

Economics

While comparing the cost involved and profit evolved *i.e.* economics of the experiment it was found that treatment N_3 i.e. 125 kg/ ha

Nitrogen was most profitable and economic in which Net income, additional income and ICBR of Rs. 3,70,449, Rs. 86,469 and 50.83, respectively was obtained. While out of two method of applications, treatment M_2 (20%Nitrogen as basal and remaining 80% in 4 equal splits at 30,50,70,90 DAS) recorded Net Income, Additional Income and ICBR of Rs. 3,22,155, Rs. 10,440 and 27.84, respectively.Variation in these profit values was due to yield obtained from different treatments which was accountable for maximum returns and benefit from different treatments.

Growth and yield parameters were significantly improved by 125 kg nitrogen per hectare when applied through 20 per cent as basal and remaining 80 per cent as top dressing in four split at 30,50,70,90 days after sowing**.**

Table.1

Treatment no.	Treatment details
T_1	75 kg N/ ha applied by 50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_2	75 kg N/ ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing
T_3	100 kg N/ha applied by50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_4	100 kg N/ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing
T_5	125 kg N/ha applied by 50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_6	125 kg N/ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing
T_7	150 kg N/ha applied by 50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_8	150 kg N/ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing
T_9	175 kg N/ha applied by 50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_{10}	175 kg N/ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing
T_{11}	200 kg N/ha applied by 50% N2 as a basal application & 50% as in two split at 45 and 75 days of sowing
T_{12}	200 kg N/ha applied by 20% N2 as a basal application & 80% as top dressing in four split at 30,50,70,90 days after sowing

Table.1 Main effect of nitrogen levels and methods of application on growth and yield of garlic cv. Agrifound White

	Plant height (cm) at 90 Days after planting				Number of leaves per plant				Days taken for bulb maturity			
	2013	2014	2015	POOLED	2013	2014	2015	POOLED	2013	2014	2015	POOLED
Nitrogen levels (N)												
N_1	61.55	52.87	62.05	58.82	7.56	6.93	7.35	7.28	166.95	154.67	164.42	162.01
N_2	64.28	53.84	65.36	61.16	8.06	6.93	7.45	7.48	163.41	154.67	166.77	161.61
N_3	65.62	58.92	67.86	64.13	8.81	7.27	7.63	7.90	156.51	154.67	159.53	156.90
N_4	64.38	55.93	64.65	61.65	9.31	7.33	7.78	8.14	158.35	154.67	163.66	158.89
N_5	63.50	53.25	63.71	60.15	9.26	7.03	7.65	7.98	171.54	154.67	156.56	160.92
N_6	64.55	56.09	67.81	62.82	9.23	7.50	7.92	8.21	170.36	154.67	157.48	160.84
S.Em±	1.90	1.38	1.78	1.24	0.42	0.20	0.22	0.16	3.05	0.12	4.82	1.86
C.D. at 5%	NS	4.09	NS	NS	1.22	NS	NS	0.48	8.89	NS	NS	NS
Methods of application (M)												
M_1	65.91	54.18	67.38	62.49	8.30	7.15	7.87	7.77	168.29	155.00	162.76	162.02
M_2	62.05	56.11	63.09	60.41	9.09	7.17	7.38	7.88	160.74	154.33	160.01	158.36
S.Em±	1.09	0.79	1.03	0.71	0.24	0.11	0.13	0.09	1.76	0.07	2.78	1.07
C.D. at 5%	3.20	NS	3.00	NS	0.70	NS	0.38	NS	5.13	0.21	NS	3.12
Interaction (N × M)												
S.Em ±	2.69	1.95	2.52	1.76	0.59	0.28	0.32	0.23	4.32	0.17	6.82	2.63
C.D. at 5%	NS	NS	7.34	5.11	NS	NS	NS	NS	NS	NS	NS	NS
Y x T												
S.Em ±				2.23				0.36				3.49
C.D. at 5%				NS				NS				NS
C. V. %	7.29	6.15	6.71	4.96	11.81	6.96	7.29	5.17	4.55	0.19	7.33	2.85

Table.2 Main effect of nitrogen levels and methods of application on growth and yieldof garlic cv. Agrifound White

	Neck thickness (cm) at harvesting				Diameter of bulb (cm)				Weight of bulb (g)			
	2013	2014	2015	POOLED	2013	2014	2015	POOLED	2013	2014	2015	POOLED
Nitrogen levels (N)												
N_1	7.02	5.27	5.27	5.85	3.44	3.00	3.05	3.16	22.87	17.57	17.63	19.36
N_2	7.86	6.14	6.55	6.85	3.57	3.06	3.17	3.27	25.25	18.40	18.52	20.72
N_3	7.04	5.25	6.68	6.32	3.63	3.31	3.37	3.44	25.87	23.33	23.25	24.15
N_4	7.46	6.02	6.51	6.66	3.47	3.17	3.27	3.30	28.75	21.80	21.88	24.14
N_5	7.18	6.14	6.64	6.66	3.63	3.02	3.09	3.24	31.18	18.83	18.62	22.88
N_6	7.15	5.62	5.62	6.13	3.57	3.04	3.12	3.24	32.68	17.83	18.07	22.86
S.Em±	0.40	0.34	0.28	0.22	0.13	0.11	0.09	0.09	0.40	1.87	1.00	0.85
C.D. at 5%	NS	NS	0.83	0.64	NS	NS	NS	NS	1.18	NS	2.92	2.49
Methods of application (M)												
M_1	6.88	5.65	6.59	6.37	3.45	3.04	3.15	3.21	27.01	19.42	19.45	21.96
M_2	7.68	5.82	5.82	6.44	3.65	3.16	3.20	3.33	28.51	19.83	19.86	22.73
S.Em±	0.23	0.19	0.16	0.12	0.07	0.06	0.05	0.05	0.23	1.08	0.58	0.49
C.D. at 5%	0.69	NS	0.48	NS	NS	NS	NS	NS	0.68	NS	NS	NS
Interaction (N × M)												
S.Em ±	0.57	0.48	0.40	0.31	0.18	0.16	0.13	0.13	0.57	2.65	1.42	1.21
C.D. at 5%	1.68	NS	1.18	0.91	NS	NS	NS	NS	1.67	NS	NS	NS
Y x T												
S.Em ±				0.44				0.15				1.46
C.D. at 5%				NS				NS				NS
C. V. %	13.76	14.67	11.28	8.44	9.11	9.37	7.55	7.13	3.59	23.39	12.52	9.40

Table.3 Main effect of nitrogen levels and methods of application on growth and yield of garlic cv. Agrifound White

	Number of cloves per bulb				Yield kg/plot				Yield q/ha			
	2013	**2014**	**2015**	**POOLED**	**2013**	**2014**	**2015**	**POOLED**	**2013**	**2014**	**2015**	**POOLED**
Nitrogen levels (N)												
N_1	13.63	14.83	14.97	14.48	3.86	2.88	3.26	3.33	110.10	82.00	92.90	95.00
N_2	14.27	16.00	16.30	15.52	4.49	3.04	3.28	3.60	127.99	86.57	93.37	102.64
N_3	17.23	17.27	17.42	17.31	4.43	4.27	4.37	4.35	126.25	121.52	124.37	124.05
N_4	16.63	17.63	17.73	17.33	4.13	3.51	4.01	3.88	117.56	99.99	114.24	110.60
N_5	18.43	18.43	19.05	18.64	4.08	3.32	3.32	3.57	116.19	94.68	94.68	101.85
N_6	19.90	16.50	16.83	17.74	4.26	3.02	3.29	3.52	121.23	86.11	93.68	100.34
S.Em±	1.18	1.9	0.82	0.79	0.37	0.30	0.21	0.18	10.54	8.60	6.02	5.24
C.D. at 5%	3.44	NS	2.39	2.31	NS	0.88	0.62	0.54	NS	25.02	17.52	15.25
Methods of application (M)												
M_1	16.47	16.82	17.18	16.82	4.37	3.11	3.46	3.64	124.62	88.60	98.70	103.98
M_2	16.88	16.73	16.91	16.84	4.04	3.56	3.71	3.77	115.14	101.67	105.70	107.51
S.Em±	0.68	0.74	0.47	0.45	0.21	0.17	0.12	0.10	6.08	4.97	3.48	3.02
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (N × M)												
S.Em ±	1.67	1.82	1.16	1.12	0.52	0.42	0.29	0.26	14.91	12.17	8.52	7.41
C.D. at 5%	4.87	NS	3.38	NS	NS	NS	NS	NS	NS	NS	NS	NS
Y x T												
S.Em ±				1.44				0.37				10.75
C.D. at 5%				NS				NS				NS
C. V. %	17.39	18.85	11.81	11.54	21.54	22.16	14.45	12.15	21.54	22.16	14.45	12.15

Table.4 Economics of the different treatments

Treatment	Pooled Yield (q/ha)	Gross Income (₹)	Treatment Cost (₹)	Net Income (₹)	Additional Income (₹)	ICBR
Nitrogen levels (N)						
N_1	95.00	2,85,000	1,020	2,83,980	-	-
N_2	102.64	3,07,920	1,361	3,06,559	22579	16.59
N_3	124.05	3,72,150	1,701	3,70,449	86469	50.83
N_4	110.60	3,31,800	2,041	3,29,759	45779	22.43
N_5	101.85	3,05,550	2,381	3,03,169	19189	8.06
N_6	100.34	3,01,020	2,722	2,98,298	14318	5.17
Methods of application (M)						
M_1	103.98	3,11,940	225	3,11,715	-	-
M_2	107.51	3,22,530	375	3,22,155	10440	27.84

Selling price= Rs.3000 per quintal Price of urea= Rs. 6.27 per kg
Labour cost= Rs. 150 per man day

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