GROWTH AND YIELD OF CUCUMBER *(CUCUMIS SATIVUS* L.*)* CULTIVARS IN RESPONSE TO DIFFERENT NITROGEN LEVELS

Niaz Ahmed Wahocho, Muhammad Iqbal Kakar, Tanveer Fatima Miano, Noor-un- Nisa Memon, Qadir Bux Baloch, Khalid Hussain Talpur, Lubna Rajput,

*Department of Horticulture, Sindh Agriculture University, Tandojam, 70060-Pakistan

*Corresponding author's email: nawahocho@gmail.com

***ABSTRACT*:** *Nitrogen is considered as one of the critical mineral nutrients for healthy growth of plants. Hence its judicious use is necessary for sustainability of crop production. The study was carried out during the year 2015 to investigate the growth and yield of cucumber (Cucumis sativus L.) cultivars in response to different nitrogen levels. The trial was conducted at the experimental area of the Department of Horticulture, Sindh Agriculture University Tandojam in randomized complete block design (RCBD) with three replications. The growth and yield performance of three cucumber cultivars (Liza, Squees Green and Sindhi Wango) were investigated to four nitrogen levels (0, 50, 100 and 150 kg ha^{-1}). The results exhibited that all the growth and yield attributes were significantly ($P<0.05$) affected by various N levels and cultivars. The crop treated with a higher N level of 150 kg significantly showed maximum values for most of the evaluated traits. The crop fertilized with N level of 150.0 kg ha^{-1} produced 198.57 cm vine length, 93.333 leaves vine^{-1}, 46.12 days to flower initiation, 16.147 cm fruit length, 14.227 fruit vine^{-1}, 2068.8 g fruit weight vine^{-1} and 16.025 tons ha^{-1} fruit yield. The results further showed that the crop fertilized with N at 100.0 kg ha^{-1} produced 174.28 cm vine length, 81.889 leaves vine^{-1}, 43.767 days to flower initiation, 14.993 cm fruit length, 12.610 fruits vine^{-1}, 1685.3 g fruit weight vine^{-1} and 12.011 tons ha^{-1} fruit yield. On the contrary control plots which were not fertilized showed an adverse effect on plant growth and yield and produced 105.62 cm vine length, 49.778 leaves vine^{-1}, 38.380 days to flower initiation, 10.380 cm fruit length, 5.497 fruit vine^{-1}, 466.6 g fruit weight vine^{-1} and 4.914 ton ha^{-1} fruit yield. Regarding the cultivars, Squees Green significantly showed better performance and comparatively produced higher values for most of the investigated traits as compared to Liza and Sindhi Wango. Moreover, among interactions, the interaction of (150 kg ha^{-1} × Squees Green) showed the maximum fruit yield 18.812 tons ha^{-1}. On the basis of the findings of the current study, it is concluded that higher N level of 150 kg ha^{-1} showed significantly higher values for most of the growth and yield investigated parameters. Hence, cucumber may be fertilized with N Level of 150 kg ha^{-1} for better growth and yield.*

Key words: Growth, yield, nitrogen levels, cucumber

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable crops of the Cucurbitaceae family [1]. It is thought to be one of the oldest vegetables cultivated by man with historical records dating back to 5,000 years [2]. The crop is the fourth most important vegetable after tomato, cabbage and onion in Asia and the second most important vegetable crop after tomato in Western Europe [2]. It is eaten as raw and generally used for salad [3]. Cucumbers are commonly harvested while still green. They can be eaten raw or cooked, or pickled. Although it is less nutritious than most fruits, the fresh cucumber seeds are still a source of vitamin C, vitamin K, and potassium, also providing dietary fiber, vitamin A, vitamin B6, thiamin, folate, pantothenic acid, magnesium, phosphorus, copper, and manganese. Cucumbers are often used in the decorative food art [4].

Cucumber is a warm season vegetable crop and it does not withstand even light frost. It tolerates a slightly cooler weather than melons, and grows best at temperatures between 18 and 24 ^{0}C. However, it can be successfully grown on a wide variety of soils from sandy to heavy clays, but greater yields are obtained from loam, silt loam or clay loam soils [5].

Nitrogen (N) is the most important macro nutrient element for growth and productivity of cucumber [6]. It plays an important role in the physiological process of the plant [7]. The appropriate rate of N application at the time of sowing leads to rapid leaf area development prolongs the life of leaves; improve leaf area duration after flowering causing an increase in the overall assimilation rate, thus contributing to increased total yield [8]. [1] reported that an increase in N application resulted in maximum fruit length, fruit weight, vine length and yield of cucumber. [9] reported that 200 kg P_2O_5 ha^{-1} along with 150 kg N and 100 kg K resulted in highest cucumber yields. [10] found that nitrogen application markedly influence the vegetative growth, bearing habit, yield and quality of fruits. [11] reported that higher fertility levels through soil resulted in a marked increase in cucumber vine growth and fruit yield as compared to lower fertility levels and control. [12] observed that the highest NPK level of 125-80-65 kg ha^{-1} showed better performance for growth and yield ssociated traits [13] reported that 100 kg N fundamentally showed fruit length (19.43 cm), fruit weight (152.2 g) and vine length (3.08 m). However 80 kg N was found better for minimizing days to blossoming (38.56), days to fruit setting (12.68) and days to fruit development (7.03) with a higher number of fruits (15.22) and eventual higher yield of cucumber was obtained (13.9 tonnes ha^{-1}). [14] found that higher application of NPK manure (100-50-50) demonstrated the significant effect for all the investigated parameters in cucumber. [15] found that use of manures demonstrated huge impact on the fruit yield of cucumber. It has been observed that N uptake and utilization is significantly affected by various plant species and sometimes genotypes of the same crop species. In this perspective, it is mandatory to investigate the influence of N on growth and yield of cultivars of cucumber.

Keeping in view role and significance of N for better development and efficiency, present research work was conducted to investigate and determine the optimum level of nitrogen for better growth and productivity of cucumber.

MATERIALS AND METHODS

The current study was carried out during the year 2015 to study the growth and yield of cucumber cultivars under the

influence of various nitrogen levels. The experiment was laid out at the experimental area of Horticulture Orchard, Department of Horticulture, Sindh Agriculture University Tandojam in a three replicated randomized complete block design with factorial arrangements. The net plot size for this experiment was kept 5 m x 3 m (15 m^2). After getting a well prepared seedbed, beds of 1.5 meter width were prepared and the seeds were sown by dibbling method on both sides of the beds at the distance of 45 cm.. Four nitrogen levels, including 0, 50, 100 and 150 kg ha^{-1} were used to assess the growth and yield of three cultivars (Liza, Sindhi Wango, Squees Green). The N was applied in the form of urea while a uniform dose of phosphorus (60 kg ha^{-1}) in the form of single super phosphate and potassium (60 kg ha^{-1}) in the form of sulfate of potash (SOP) was applied. A full dose of phosphorus and potassium and one third of the N was applied at the time of sowing by mixing well in the soil. The remaining N was applied in two equal split doses, the first split was applied at the time of flowering and the remaining dose of urea was applied at the time of fruit development. Each application of fertilizer was immediately followed by irrigation. All the required cultural practices, including weeding, hoeing were applied in all the plots uniformly throughout the growth period of the crop. The observations were recorded on economically important traits of cucumber such as vine length (cm), leaves $vine^{-1}$, days to flower initiation, fruit length (cm), fruits $vine^{-1}$, fruit weight $vine^{-1}$ (kg) and fruit yield (tons ha^{-1}).

Statistical analysis

The data were statistically analyzed using Statistix- 8.1 computer software [16]. The least significant difference (LSD) test was applied at $P \leq 0.05$ probability level to compare treatments superiority.

RESULTS AND DISCUSSION

Vine length (cm)

The vine length was significantly affected by various N levels, cultivars and their interactions. The results indicated that cucumber cultivar Squees green produced plants of maximum vine length (165.83 cm) while the lowest vine length (154.98 cm and 141.03 cm) was observed in cultivars Liza and Sindh Wango (Table 1). The effect of nitrogen levels showed that the cucumber vine receiving higher nitrogen levels of 150.0 kg ha^{-1} and 100.0 kg ha^{-1} produced a maximum vine length, i.e. 198.57 cm and 174.28 cm, respectively as compared to lower nitrogen levels. The reduction in nitrogen levels up to 50.0 kg ha^{-1} resulted in a simultaneous reduction in vine length up to 137.31 cm. The minimum vine length (105.62 cm) was noted in plots where nitrogen was not applied (control). The LSD test further suggested indicated that the differences in vine length between 150 kg and 100 kg N levels were statistically significant ($P<0.05$). Vine length in cucurbit crops is generally a major growth trait and different cultivars can grow variably and their growth can be affected by environment factors as well as nutrient application. In the present study, the increase in vine length under higher nitrogen levels was mainly associated with the adequacy of N in the soil after its application, resultantly the vine length improved markedly. These results are in agreement with those of [17] who found that higher N levels resulted in an increased vine length of the cucumber.

Leaves $vine^{-1}$

The results in relation to leaves $vine^{-1}$ revealed a significant ($P<0.05$) differences between cultivars and nitrogen levels. Moreover, the interactive effect of cultivars and nitrogen levels was also significant ($P<0.05$) on leaves $vine^{-1}$. The maximum leaves (78.00) $vine^{1}$ was recorded in cucumber cultivar Squees Green and minimum leaves (72.917 and 66.250) $vine^{-1}$ was noted in variety Liza and Sindh Wango (Table 2). The effect of nitrogen levels showed that the leaves was higher (93.333 and 81.889) $vine^{-1}$ in crop receiving higher nitrogen levels of 150.0 kg ha^{-1} and 100.0 kg ha^{-1}, respectively. The leave decreased to 64.556 $vine^{-1}$ when the cucumber crop was fertilized with N @ 50.0 kg ha^{-1}. However, the lowest leaves (49.778) $vine^{-1}$ was noted in control plots where nitrogen was not applied. The increased leaves $vine^{-1}$ might have been associated with application of N in large quantity that increased the fertility of soil, consequently the leaves $vine^{-1}$ increased significantly. The beneficial effect of N on leaves $vine^{-1}$ of cucumber is also reported by [9], who documented that N application at 150 kg ha^{-1} showed maximum leaves $vine^{-1}$ of cucumber.

Days to flower initiation

Various N levels and cultivars had significant ($P<0.05$) effects on days to flower initiation. However, the interaction effect of cultivars and nitrogen levels was non-significant ($P>0.05$). The maximum days to flower initiation (44.275) was recorded in cucumber cultivar Squees Green and minimum days to flower initiation (42.167 and 41323) was noted in variety Liza and Sindh Wango (Table 3). The effect of nitrogen levels showed that the days to flower initiation was higher (46.123 and 43.767) in crop receiving higher nitrogen levels of 150.0 kg ha^{-1} and 100.0 kg ha^{-1}, respectively. The days to flower initiation decreased to (42.083) when the cucumber crop was fertilized with N @ 50.0 kg ha^{-1}. However, the lowest days to flower initiation (38.380) was noted in control plots where N was not applied. In the present investigation, the N applied at larger quantity revealed maximum days to initiate first flowers. This might have been attributed to enhanced vegetative growth of plants under application of higher N levels resultantly plants took more days to initiate flowering. These results are further supported by [18] who also found delayed flowering in okra under higher N level.

Fruit length (cm)

The results revealed that fruit length of cucumber was significantlly ($P<0.05$) influenced by cultivars and nitrogen levels, and interactive effect of Cultivar and nitrogen levels was non-significant ($P>0.05$) on fruit length. The maximum fruit length (15.862 cm) was observed in cucumber cultivar Sindh Wango, while the fruits with less length (13.042 cm) were noted in cultivar Squees Green, whereas the minimum fruit length (11.750 cm) was noted in Liza (Table 4). The effect of nitrogen levels showed that the fruit length was maximum (16.147 cm and 14.993 cm) in crop receiving higher nitrogen levels of 150.0 kg ha^{-1} and 100.0 kg ha^{-1}, respectively. The fruit length decreased to 12.687 cm when the cucumber crop was fertilized with N @ 50.0 kg ha^{-1}, respectively. However, the lowest fruit length (10.380 cm)

was noted in control plots where nitrogen was not applied (Table 4). Fruit length is an important parameter that heavily affects the total yield of cucumber. In the present study, the highest fruit length might have been attributed to the availability of essential nutrients, especially of N in the soil that significantly enhanced the fruit length. The minimum fruit length in control plots might be due to poor nutritional status of the soil resultantly the plants with minimum fruit length were obtained. These results are endorsed by [12] who reported that the highest N level of 125 kg ha^{-1} showed better fruit length. Similar results were also reported by [19], who also found positive effects of N on fruit length in Chilli.

Fruit vine^{-1}

The fruits vine^{-1} was significantly (P<0.05) increased by cultivars and nitrogen levels. similarly, the interactive effect of cultivars and nitrogen levels also showed significant (P<0.05) influence on fruit vine $^{-1}$. The maximum fruits (11.483) vine^{1} was recorded in Squees Green and minimum fruits (10.833 and 9.208) vine^{-1} was noted in Liza and Sindh Wango (Table 5). The effect of nitrogen levels showed that the fruit was maximum (14.227 and 12.610) vine^{-1} in crop receiving maximum nitrogen levels of 150.0 kg ha^{-1} and 100.0 kg ha^{-1}, respectively. The fruits number decreased to 9.700 vine^{-1} when the cucumber crop was fertilized with N @ 50.0 kg ha^{-1}, respectively. However, the lowest fruits (5.497) vine^{-1} was noted in control, where nitrogen was not applied. These results reflected that balanced supply of N enhanced the growth of plants, eventually more fruits vine^{-1} were produced. In contrast, minimum fruits might be attributed to the lowest amount of nutrients, especially of N applied to the soil resultantly less fruits vine^{-1} were produced. These results are in accordance with the findings of [14], who described that fruits vine^{-1} were significantly increased with the application of increasing N levels. The present results are in accordance with those of [20], who also observed significant improvement in fruits vine^{-1} under increased N levels.

Fruit weight vine^{-1} (g)

The data in relation to fruit weight vine^{-1} of three cucumber cultivars as influenced by various levels of nitrogen are shown in Table-6. The analysis of variance indicated that there was significant (P<0.05) effect of N levels and cultivars on the fruit weight vine^{-1} of cucumber. The results indicated that the fruit weight vine^{-1} was maximum (1577.5 g) in Squees Green, whereas Liza produced 1417.3 g of fruits weight vine^{-1}. The weight of fruits further decreases to 975.8 g in case of Sindh Wango. The effect of nitrogen levels shows that the maximum fruits weight vine^{-1} (2068.8 g) was noted when N was applied at the highest rate of 150.0 kg ha^{-1}, followed by 1685.3 g and 1073.6 g average fruit weight vine^{-1} recorded from the plots fertilized with N levels of 100.0 kg ha^{-1} and 50.0 kg ha^{-1}, respectively; while the lowest fruit weight vine^{-1} (466.6 g) was obtained from control plots, where nitrogen was not applied. This reflects that balanced the application of N to the crop the superior was the fruit weights vine^{-1}. These findings are in line with the results of [13], who also found beneficial and significant effects of N on the fruits weight vine^{-1}. Moreover, similar results were also reported by [21], who described that N application at 150 kg ha^{-1} produced maximum fruits vine^{-1}.

Fruit yield (tons ha^{-1})

The data in relation to fruit yield (tons ha^{-1}) showed that there was a significant (P<0.05) effect of nitrogen levels and cultivars on cucumber fruit yield ha^{-1}; moreover the interactive effect of nitrogen levels x cultivars also revealed significant (P<0.05) differences for this parameter. In case of cultivars, the fruit yield of the cucumber cultivar "Squees Green," was higher (12.114 tons ha^{-1}) as compared to "Liza and Sindh Wango" which was obtained (11.217 and 7.628 ton ha^{-1}), respectively (Table 7). Regarding the N levels, the results indicated that the fruit yield was highest (16.025 ton ha^{-1}) when nitrogen was applied at the rate of 150.0 kg ha^{-1}, followed by fruit yield of 12.011 ton ha^{-1} obtained from the plots fertilized with nitrogen level of 100.0 kg ha^{-1} (Table 7). The crop fertilized with lower nitrogen levels of 50.0 kg ha^{-1} produced fruit yield of 8.329 tons ha^{-1}. The lowest fruit yield (4.914 tons ha^{-1}) was obtained in control plots. Fruit yield relies on several plant parameters including vine length, fruit length, fruits vine^{-1} and weight of fruits vine^{-1}. In the current study balance application of N to the soil enhanced both vegetative and reproductive growth of the crop, eventually, the fruit yield increased significantly. These results are in accordance with the findings of [14] who reported that fruit yield of cucumber enhanced significantly with increasing N level. These results are further supported by [19] and [22] who documented that higher N levels positively influence the yield of chilli and brinjal.

Table 1: Vine length (m) of three cucumber Cultivar under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	106.33	113.78	96.76	105.62 D
N_2= 50.0 kg ha^{-1}	138.23	147.91	125.79	137.31 C
N_3= 100.0 kg ha^{-1}	175.45	187.73	159.66	174.28 B
N_4= 150.0 kg ha^{-1}	199.91	213.90	181.92	198.57 A

	Treatments (T)	Cultivars (C)	T X C
S.E.±	1.7124	1.4830	2.9660
LSD 0.05	3.5513	3.0755	6.1510

Table 2: Leaves vine^{-1} of three cucumber Cultivar under different nitrogen fertilizer levels

Treatments	Cultivars			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	50.33	53.33	45.67	49.778 D
N_2= 50.0 kg ha^{-1}	65.00	69.67	59.00	64.556 C
N_3= 100.0 kg ha^{-1}	82.33	88.33	75.00	81.889 B
N_4= 150.0 kg ha^{-1}	94.00	100.67	85.33	93.333 A
Mean	72.917 B	78.000 A	66.250 C	-

	Treatments (T)	Cultivars (C)	T X C
S.E.±	0.8405	0.7279	1.4559
LSD 0.05	1.7432	1.5096	3.0193

Table 3: Days to flower initiation of three cucumber cultivars under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	38.000	39.900	37.240	38.380 C
N_2= 50.0 kg ha^{-1}	41.667	43.750	40.833	42.083 B
N_3= 100.0 kg ha^{-1}	43.333	45.500	42.467	43.767 B
N_4= 150.0 kg ha^{-1}	45.667	47.950	44.753	46.123 A
Mean	42.167 B	44.275 A	41.323 C	-

	Treatments (T)	Cultivars (C)	T X C
S.E.±	0.2383	0.2064	0.4127
LSD 0.05	0.4942	0.4280	0.8559

Table 4: Fruit length (cm) of three cucumber cultivars under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	9.000	9.990	12.150	10.380 D
N_2= 50.0 kg ha^{-1}	11.000	12.210	14.850	12.687 C
N_3= 100.0 kg ha^{-1}	13.000	14.430	17.550	14.993 B
N_4= 150.0 kg ha^{-1}	14.000	15.540	18.900	16.147 A
Mean	11.750 C	13.042 B	15.862 A	-

	Treatments (T)	Cultivar (C)	T X C
S.E.±	0.4970	0.4304	0.8609
LSD 0.05	1.0308	0.8927	1.7853

Table 5: Fruit vine^{-1} of three cucumber cultivars under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	5.667	6.007	4.817	5.497 D
N_2= 50.0 kg ha^{-1}	10.000	10.600	8.500	9.700 C
N_3= 100.0 kg ha^{-1}	13.000	13.780	11.050	12.610 B
N_4= 150.0 kg ha^{-1}	14.667	15.547	12.467	14.227 A
Mean	10.833 B	11.483 A	9.208 C	-

	Treatments (T)	Cultivar (C)	T X C
S.E.±	0.3479	0.3013	0.6025
LSD 0.05	0.7214	0.6248	1.2495

Table 6: Fruit weight vine^{-1} (g) of three cucumber cultivars under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	499.7	556.1	344.0	466.6 D
N_2= 50.0 kg ha^{-1}	1149.7	1279.6	791.5	1073.6 C
N_3= 100.0 kg ha^{-1}	1804.7	2008.6	1242.5	1685.3 B
N_4= 150.0 kg ha^{-1}	2215.3	2465.7	1525.3	2068.8 A
Mean	1417.3 B	1577.5 A	975.8 C	-

	Treatments (T)	Cultivar (C)	T X C
S.E.±	44.866	38.855	77.710
LSD 0.05	93.046	80.580	161.16

Table 7: Fruit yield (tons ha^{-1}) of three cucumber cultivars under different nitrogen fertilizer levels

Treatments	Cultivar			Mean
	Liza	Squees Green	Sindh Wango	
N_1= 0.0 kg ha^{-1}	5.341	5.768	3.632	4.914 D
N_2= 50.0 kg ha^{-1}	9.053	9.777	6.156	8.329 C
N_3= 100.0 kg ha^{-1}	13.056	14.100	8.878	12.011 B
N_4= 150.0 kg ha^{-1}	17.419	18.812	11.844	16.025 A
Mean	11.217 B	12.114 A	7.628 C	-

	Treatments (T)	Cultivar (C)	T X C
S.E.±	0.2151	0.1863	0.3725
LSD 0.05	0.4461	0.3863	0.7726

CONCLUSION

Based on the findings of the present study, it is concluded that higher N level of 150 kg ha^{-1} showed

Significantly higher values for most of the growth and yield investigated parameters. For cultivar, Squees Green comparatively revealed better performance as compared to Liza and Sindhi Wango under all nitrogen levels for most of the evaluated traits. Hence, cucumber may be fertilized with N Level of 150 kg ha^{-1} for better growth and yield.

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