Effect of various doses of nitrogen on infestation rate of whitefly in *Gossypium hirsutum* L.

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Abstract: Cotton is an important cash crop of Pakistan. It is highly infested by insect pests every year. Insect population on a crop is dependent on plant nutrition. In this research, an experiment was conducted to study the impact of nitrogen application on infestation of whitefly on two different genotypes Lalazar and MH-114 at research area of department of Agronomy, University of Agriculture, Faisalabad. Three doses of Nitrogen 50kg/ ha, 80kg/ha, and 140kg/ha was used following Randomized Complete Block Design with three replications. Data of whitefly infestation (adults and nymphs) was recorded on weekly basis for consecutive four months. Data of weather factors was taken from Weather Station University of Agriculture Faisalabad. Statistical analysis of recorded data was carried out to compare the mean population of whitefly in different nitrogen treatments on two cotton genotypes. Results will be analyzed statistically using Statistix 8.1. Results indicate that that high dose of the nitrogen showed higher whitefly population as compared to recommended and low dose. The low dose of the nitrogen showed lower population of whitefly as compared to the recommended and high dose.

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Introduction

Cotton is cash crops of Pakistan (Rasheed *et al*., 2018). Cotton perform a major role in uprising of Pakistan's economy is or therefore, called as White Gold. Cotton shares 57% in earning foreign exchange in Pakistan economy (Asif *et al*.,2017). Sucking insect pest mostly prefer American cotton (*Gossypium hirsutum*) to feed as compared to desi cotton. Lepidopterous species were virtually restrained from damaging transgenic Bt cotton. (Zafar et al., 2018).

Pakistan is at 4th rank in growing cotton and stands at 3rd rank as exporter of raw cotton in the world (Abbas et al., 2016). In Pakistan, insect pests can cause up to 20%-40% loss to cotton crop. With the growing population, it is necessary to control insect pests to redeem the clothing and food quality and quantity to comply the need of people and this is possible by introducing new resistant varieties. Many new genotypes were introduced in cotton to cause resistance in cotton insect pest (Imran et al., 2017).

Coton white fly *Bemesia tabaci* (Gennadius) (Homoptera: Aleyrodidae) is one the major insect pest which sucks the cell sap of plant and excrete honeydews which enhance sooty mould that reduces photosynthesis and thus have bad impact on the production of yield. A huge amount of yield is reduced by transmitting 111 viruses by *Bemisia tabaci* (Rasheed *et al*.,2018). Amount of nitrogen in plants has been recommended as an indicator of host quality for herbivorous insects. (Teshome et al., 2016). Whitefly among all other sucking insect pest of cotton have great influence of biotic and abiotic factors such as rainfall, temperature and relative humidity specially in cropping season (Zafar et al., 2017). The increase in relative humidity and temperature have great influence on the dynamics of population of whitefly in cotton (Harvey et al., 2017). Different agricultural practices are responsible for insect pest outbreak that include irrigation, as both over and less irrigation may trigger insect pest outbreak. Planting date is also one of the major factors of insect attack, less planting distance congested the plants and provide more suitable place for insects. Fertilizer doses determine pest attack on crop besides pesticides, which otherwise may cause resistance in insects (Jallani et al., 2017). In this research, an experiment was conducted to study the impact of nitrogen application on infestation of whitefly on two different genotypes of cotton.

Materials And Methods

The experiment was conducted in the experimental field of Agronomy Department, UAF to check the impact of plant nutrient on seasonal abundance of whitefly on BT cotton varieties MH-114 and Lalazar. Sowing was started at the last week of April 2018. Cotton variety MH-114 and Lalazar were used for study. Sugarcane, Cotton and Maize were commonly sowing here. Area is affected by number of

sucking (jassid, aphid, whitefly, thrips, red cotton bug, etc.) & chewing (borers, bollworms, leaf folder etc.) pests. Irrigation is provided via canal water. Fifty-four treatments were used including application of nitrogen applied by split and single method. In this experiment, three doses of the Nitrogen are used in single dose application as well as split dose application. In the application of doses three level are applied such as low dose, recommended dose and high dose. In split method the first dose was applied after four weeks and second dose was applied when the flowering stage started and third dose was applied during boll formation.

Experimental Layout

Area of the total experiment is 2414.63 m^2, into two blocks one for each variety and each block was further divided into twelve sub-blocks with 3 replications. The size of each sub-block is 25.23 m^2. In this experiment, the dose rates are defined in table 3.3.

Table 1. Dose Rates

Fertilizer	Low Dose	Recommended Dose	High Dose
Urea	336/g	673/g	1369/g

Data Collection:

Eggs are creamy white. Nymphs are pale yellow. Female lays 100-150 stalked eggs in lower side of the leaves. Whiteflies were counted by using 5plant method in which five random plants from one block were selected and whiteflies were counted from different leaves at different height then calculate the mean of population for further data analysis.

Results and discussion

Effect nitrogen on population abundance of whitefly for the last week of June

Analysis of variance revealed that different stages of nitrogen had significant effect (F = 140.75; df = 3,6; P = 0.00) on population incidence of whitefly after last week of June (table 1). Maximum whitefly population (3.0 ± 0.65/ 5 plants) was observed on cotton plot treated with nitrogen level one (N_1) followed by (2.0 ± 0.52/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with nitrogen level three (N_3) and control treatment © showed statistically non-significant population flection (1.5 ± 0.42/ 5 plants) and (1.6 ± 0.38/ 5 plants) respectively (Table 2). Results indicated that lower nitrogen level show higher number of whitefly population.

ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions

Source	DF	SS	MS	F	P
Treatments	3	0.22167	1.11083		
Block	2	6.52667	0.17556	132.75	0.0001
Error	7	0.09833	1.01639		
Total	12	6.84667			

G. M = 2.57, **CV**= 4.94

Table 2. Meens comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of June

Treatment	Mean ± S.E.
N_1	3.7333
N_2	2.6667
N_3	1.9667
Control	1.9000

Effect of different levels of nitrogen on population abundance of whitefly for the 1st seven days (week) of July

The analysis of variance showed that the effect of different levels of nitrogen had significant result (F = 30.23; df = 3,6; P = 0.05) on population incidence of whitefly after 1st week of July (Table 3). Maximum whitefly population (3.1 ± 0.95/ 5 plant) was observed on cotton plot treated with nitrogen level one (N_1) followed by (2.6 ± 0.89/ 5 plant) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with Nitrogen level three (N_3) and control treatment (C) showed statistically non-significant population flection (2.4 ± 0.76/ 5 plant) and (3.2 ± 0.72/ 5 plant) respectively (Table 4). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 3. ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions the 1st week of July

Source	DF	SS	MS	F	P
TREATMENTS	3	0.18167	0.09083		
BLOCK	2	3.39000	1.13000	64.57	0.0001
Error	7	0.10500	0.01750		
Total	12	3.67667			

G M = 3.41, **CV**= 3.87

Table 4. Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 1st week of July

Treatment	Mean± S.E.
N_1	3.1 ± 0.95^{A}
N_2	2.6 ± 0.89^{A}
N_3	2.4 ± 0.76^{B}
Control	3.2 ± 0.72^{B}

Effect of different nitrogen levels on population abundance of whitefly for the 2st week of July

The analysis of variance showed that the effect of different levels of nitrogen has significant effect (F = 987.00; df = 3,6; P = 0.00) on population incidence of whitefly after 2st week of July (Table 5). Maximum whitefly population (2.8 ± 0.408/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (2.4 ± 0.321/ 5 plants) on cotton plot treated with nitrogen level one (N_1). While cotton plot treated with Nitrogen level two (N_2) and control treatment (C) showed statistically non-significant population flection (2.6 ± 0.201/ 5 plants) and (4.8 ±0.246/ 5 plants) respectively. Results designated that higher nitrogen level show higher number of whitefly population.

Table 5: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2st week of July

Source	DF	SS	MS	F	P
TREATMENTS	3	0.04500	1.02250		
BLOCK	2	4.44917	2.48306	82.14	0.00001
Error	7	0.10833	1.01806		
Total	12	4.60250			

G M = 3.52, **CV**= 3.81

Table 6: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2st week of July

Treatment	Mean± S.E.
N_1	2.4 ± 0.321^{B}
N_2	2.6 ± 0.201^{C}
N_3	2.8 ± 0.408^{A}
Control	4.8 ± 0.246^{C}

Table 7: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of July

Source	**DF**	**SS**	**MS**	**F**	**P**
TREATMENTS	2	0.1950	0.0975		
BLOCK	3	43.6425	14.5475	698.28	0.0000
Error	6	0.1250	0.0208		
Total	11	43.9625			

Gr M = 6.57, **CV**= 1.52

Effect of different levels of nitrogen on population abundance of whitefly on MH-114 for the 3rd week of July

The analysis of variance showed that the effect of different levels of nitrogen has significant effect (F = 890.75; df = 3,6; P = 0.00) on population incidence of whitefly after 3rd week of July (Table 7). Maximum

whitefly population (4.5 ± 0.40/ 5 plants) was observed on cotton plot with control treatment (C) followed by (7.1 ± 0.31/ 5 plants) on cotton plot treated with nitrogen level three (N_3). While cotton plot treated with Nitrogen level two (N_2) and nitrogen level one (N_1) showed statistically non-significant population flection (8.6 ± 0.24/ 5 plants) and (6.1 ± 0.16/ 5 plants) correspondingly. Results indicated that in control treatment show higher number of whitefly population.

Table 8: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of July

Treatment	Mean ± S.E.
N_1	6.1 ± 0.16^{D}
N_2	8.6 ± 0.24^{C}
N_3	7.1 ± 0.31^{B}
Control	4.5 ± 0.40^{A}

Effect of different levels of nitrogen on population abundance of whitefly for the last week of July

The analysis of variance showed that the effect of different levels of nitrogen had significant result (F = 1692.00; df = 3,6; P = 0.00) on population incidence of whitefly after last week of July (Table 9). Maximum whitefly population (6.2 ± 0.70/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (5.3 ± 0.62/ 5 plants) on cotton plot treated with nitrogen level one (N_1). While cotton plot treated with Nitrogen level two (N_2) and control treatment (C) showed statistically non-significant population flection (4.6 ± 0.54/ 5 plants) and (4.2 ± 0.43/ 5 plants) respectively. Consequences designated that higher nitrogen level show higher number of whitefly population.

Table 9: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of July

Source	DF	SS	MS	F	P
TREATMENTS	2	0.0450	0.02250		
BLOCK	3	15.7892	5.26306	167.67	0.0000
Error	6	0.1883	0.03139		
Total	11	16.0225			

G M = 5. 85, **CV**= 1. 48

Table 10: Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of July

Treatment	Mean ± S.E.
N_1	5.3 ± 0.62^{B}
N_2	4.6 ± 0.54^{C}
N_3	6.2 ± 0.70^{A}
Control	4.2 ± 0.43^{D}

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Table 11 ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 1st week of August

Source	DF	SS	MS	F	P
TREATMENTS	2	0.00500	0.00250		
BLOCK	3	2.28667	0.76222	42.22	0.0002
Error	7	0.10833	0.01806		
Total	12	2.40000			

Grand Mean = 3.79, **CV**= 2.95

Effect of different levels of nitrogen on population abundance of whitefly for the 1st seven days (week) of August

The analysis of variance showed that the effect of different levels of nitrogen had important result (F = 104.60; df = 3,6; P = 0.00) on population incidence of whitefly after 1st week of August (Table 11). Maximum whitefly population was observed on cotton plot treated with nitrogen level two (N_2) and nitrogen level three (N_3) (4.1 ± 0.91/ 5 plants) and (4.1 ± 0.86/ 5 plants) respectively. While cotton plot with control treatment (C) show minimum population of whitefly

(3.5 ± 0.79) and cotton plot treated with nitrogen level one (N_1) showed statistically non-significant population flection (3.1 ± 0.70/ 5 plants) (Table 12). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 12: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 1st week of August

Treatment	Mean± S.E.
N_1	3.1 ± 0.70^C
N_2	4.1 ± 0.91^A
N_3	4.1 ± 0.86^A
Control	3.5 ± 0.79^B

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Effects of different levels of nitrogen on population abundance of whitefly for the 2nd week of the August

The analysis of variance showed that the effect of different levels of nitrogen had important result (F = 250.20; df = 3,6; P = 0.00) on population incidence of whitefly after 2nd week of August (Table 13). Maximum whitefly population (10.1 ± 0.81/ 5 plants) was observed on cotton plot treated with Control treatment (C) followed by (9.8 ± 0.74/ 5 plants) on cotton plot treated with nitrogen level three (N_3). While cotton plot treated with Nitrogen level two (N_2) and Nitrogen level one (N_1) showed statistically non-significant population flection (8.6 ± 0.66/ 5 plants) and (7.1 ± 0.55/ 5 plants) respectively (Table 14). Results indicated that control treatment show higher number of whitefly population.

Table 13: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2nd week of August

Source	DF	SS	MS	F	P
TREATMENTS	2	0.0350	0.01750		
BLOCK	3	16.1492	5.38306	553.69	0.0000
Error	6	0.0583	0.00972		
Total	11	16.2425			

G M = 9.92, **CV**= 1.13

Table 14: Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2nd week of August.

Treatment	Mean ± S.E.
N_1	7.1 ± 0.55^D
N_2	8.6 ± 0.66^C
N_3	9.8 ± 0.74^B
Control	10.1 ± 0.81^A

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Table 15: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of August

Source	DF	SS	MS	F	P
TREATMENTS	2	0.5600	0.28000		
BLOCK	3	18.6958	6.23194	20.47	0.0005
Error	6	1.8267	0.30444		
Total	11	21.0825			

G M = 6.67, **CV**= 1.50 *

Result of different levels of nitrogen on population abundance of whitefly for the 3rd week of August

The analysis of variance showed that the effect of different levels of nitrogen had important result (F = 6.67; df = 3,6; P = 0.00) on population incidence of whitefly after 3rd week of August (Table 15). Maximum whitefly population (8.1 ± 0.70/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (6.0 ± 0.61/ 5 plants) on cotton plot treated with control treatment (C). While cotton plot treated with nitrogen level two (N_2) and nitrogen level one (N_1) showed statistically non-significant

population flection (4.3 ± 0.52/ 5 plants) and (4.4 ± 0.48/ 5 plants) respectively (Table 16). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 16: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of August

Treatment	Mean ± S.E.
N_1	4.4 ± 0.48^{C}
N_2	4.3 ± 0.52^{C}
N_3	8.1 ± 0.70^{A}
Control	6.0 ± 0.61^{B}

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Effect of different levels of nitrogen on population abundance of whitefly for the last week of August

The analysis of variance showed that the effect of different levels of nitrogen had important result (F = 140.75; df = 3,6; P = 0.00) on population incidence of whitefly after last week of August (Table 4.1.17). Maximum whitefly population (6.1 ± 0.47/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (3.1 ± 0.40/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with nitrogen level one (N_1) and control treatment (C) showed statistically non-significant population flection (3.5 ± 0.33/ 5 plants) and (2.8 ± 0.23/ 5 plants) respectively (Table 4.1.18). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 17: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of August

Source	DF	SS	MS	F	P
TREATMENTS	2	0.00167	0.00083		
BLOCK	3	8.31000	2.77000	158.29	0.0000
Error	6	0.10500	0.01750		
Total	11	8.41667			

G M = 3.92, **CV**= 2.21

Table 18: Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of August

Treatment	Mean ± S.E.
N1	3.5 ± 0.33^{C}
N2	3.1 ± 0.40^{B}
N3	6.1 ± 0.47^{A}
Control	2.8 ± 0.23^{D}

Effect of different levels of nitrogen on population abundance of whitefly for the 1st week of September

Analysis of variance table revealed that dissimilar stages of nitrogen had important result (F = 2872.00; df = 3,6; P = 0.00) on population incidence of whitefly after 1st week of September (Table 19). Maximum whitefly population (7.2 ± 0.77/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (4.7 ± 0.70/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with nitrogen level one (N_1) and control treatment (C) showed statistically non-significant population flection (8.4 ± 0.61/ 5 plants) and (6.5 ± 0.51/ 5 plants) respectively (Table 20). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 19: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 1st week of September

Source	DF	SS	MS	F	P
TREATMENTS	2	0.0867	0.04333		
BLOCK	3	13.3933	4.46444	574.00	0.0000
Error	6	0.0467	0.00778		
Total	11	13.5267			

G M = 6.70, **CV**= 0.75

Table 20: Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 1st week of September

Treatment	Mean ± S.E.
N_1	8.4 ± 0.61^{C}
N_2	4.7 ± 0.70^{B}
N_3	7.2 ± 0.77^{A}
Control	6.5 ± 0.51^{D}

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Effect of different levels of nitrogen on population abundance of whitefly for the 2nd week of September

Analysis of variance table revealed that different levels of nitrogen had important result (F = 62.75; df = 3,6; P = 0.00) on population incidence of whitefly after 2nd week of September (Table 21). Maximum whitefly population (6.1 ± 0.408/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (6.8 ± 0.339/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with nitrogen level one (N_1) and control treatment (C) showed statistically non-significant population flection (5.3 ± 0.264/ 5 plants) and (5.1 ± 0.206/ 5 plants) respectively (Table 22). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 21: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2nd week of September

Source	DF	SS	MS	F	P
TREATMENTS	2	0.0650	0.03250		
BLOCK	3	11.3400	3.78000	1512.00	0.0000
Error	6	0.0150	0.00250		
Total	11	11.4200			

G M = 5.57, **CV**= 1.79

Table 22: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 2nd week of September

Treatment	Mean ± S.E.
N_1	5.3 ± 0.264^{C}
N_2	6.8 ± 0.339^{B}
N_3	6.1 ± 0.408^{A}
Control	5.1 ± 0.206^{D}

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Effect of different levels of nitrogen on population abundance of whitefly for the 3rd week of September

Analysis of variance table revealed that dissimilar stages of nitrogen had significant result (F = 448.43; df = 3,6; P = 0.00) on population incidence of whitefly after 3rd week of September (Table 23). Maximum whitefly population (8.1 ± 0.70/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (5.7 ± 0.62/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with control treatment (C) and with nitrogen level one (N_1) showed statistically non-significant population flection (7.7 ± 0.54/ 5 plants) and (7.5 ± 0.45/ 5 plants) respectively (Table 24). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 23: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of September

Source	DF	SS	MS	F	P
TREATMENTS	2	0.05167	0.02583		
BLOCK	3	6.13667	2.04556	253.93	0.0000
Error	6	0.04833	0.00806		
Total	11	6.23667			

G M = 7.28, **CV**= 1.21

Table 24: Means comparisons of population profusion of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the 3rd week of September

Treatment	Mean ± S.E.
N1	7.5 ± 0.45^{D}
N2	5.7 ± 0.62^{B}
N3	8.1 ± 0.70^{A}
Control	7.7 ± 0.54^{C}

The method of sharing similar letters did not differ significantly when the probability level was 5%.

Effect of different levels of nitrogen on population profusion of whitefly for the last week of September

Analysis of variance table revealed that dissimilar stages of nitrogen had important result (F = 989.33; df = 3,6; P = 0.00) on population incidence of whitefly after last week of September (Table 25). Maximum whitefly population (6.0 ± 0.40/ 5 plants) was observed on cotton plot treated with nitrogen level three (N_3) followed by (5.5 ± 0.31/ 5 plants) on cotton plot treated with nitrogen level two (N_2). While cotton plot treated with nitrogen level one (N_1) and control treatment (C) showed statistically non-significant population flection (3.1 ± 0.24/ 5 plants) and (3.0 ± 0.17/ 5 plants) respectively (Table 26). Results indicated that higher nitrogen level show higher number of whitefly population.

Table 25: ANOVA for population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of September

Source	DF	SS	MS	F	P
TREATMENTS	2	0.0650	0.03250		
BLOCK	3	11.9100	3.97000	1588.00	0.0000
Error	6	0.0150	0.00250		
Total	11	11.9900			

G M = 4.40, **CV**= 1.97

Table 26: Means comparisons of population abundance of whitefly (*Bemisia tabaci*) at different nitrogen level at field conditions for the last week of September

Treatment	Mean ± S.E.
N_1	3.1 ± 0.24^{C}
N_2	5.5 ± 0.31^{B}
N_3	6.0 ± 0.40^{A}
Control	3.0 ± 0.17^{D}

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