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REVIEW ARTICLE

Effect of Foliar Application of Nano-NPK Fertilizer on Growth and Yield of Broad bean *(Vicia Faba L.)*

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A B S T R A C T:

A field research was conducted during season 2019/2020 in Gradrasha field, collage of agricultural Engineering sciences at Salahaddin University, to evaluate the effect of foliar application of Nano- NPK fertilizer at different levels (0, 30, 60, 90 and 120 mg.l^{-1}) for one and two times on growth and yield of (*Vicia faba* L.). The research was applied as foliar application of Nano-NPK at different levels (0, 30, 60, 90 and 120 mg.l^{-1}). The results shows significant effect on most studied treatment. The results indicated that number of foliar application had significant influence on most vegetative, yield and yield component parameters, the best results were obtained from twice foliar application, the best values of number of branches.plant^{-1}, chlorophyll content in leaves%, and dry matter of leaves (334.416, 5.381, 46.949 %, 22.789 % respectively) were obtained at the twice foliar application of Nano-NPK. However, the highest results of plant height, number of branches. plant^{-1}, number of leaves. plant^{-1}, leaves chlorophyll content %, dry matter in leaves and TSS in seed (131.448cm, 365.995, 6.120, 51.592%, 25.435ghighes and 16.107% respectively) were recorded from (120mg.l^{-1}) of Nano- NPK.
Moreover the foliar application of (120mg.l^{-1}) Nano-NPK for two times gave highest significant effects on vegetative growth, yield and yield component.

KEY WORDS: ***Bean, Nano-NPK fertilizer, vegetative growth, yield, chlorophyll.***
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1. INTRODUCTION:

Broad bean (*Vicia faba* L.) is a legume member family, grown initially for edible pods and seeds. It has an upright growth that grows up to 1-2m height, it has main taproot and adventitious roots that spread to 0.90 m in width (Muehlbauer *et al.,* 1997). The broad bean can be harvested as a vegetable when the seeds are immature and green, or harvested at the maturity stage when the seeds are dry (Singh *et al.*, 2013.)

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It is rich in protein that use as a source of human diet, and can be used in crop rotation to restore soil fertility and soil properties (Jasim, 2007). The top five production countries are China, Ethiopia, Australia, France and Egypt. Additionally, fresh and dry seeds of broad bean are consist of many elements like potassium, Calcium, Manganese, Iron, and Zinc (Neme *et al.*, 2015; Longobardi *et al.*, 2015; Lizarazo *et al.*, 2015).
Traditional usage of fertilizer whether organic or chemical, could be make a problem to the soil; huge quantities uses may cause ground water and soil pollution, shortage micronutrient and soil degradation, eventually lead to decrease production (Meena *et al.,* 2017). However, all kinds of fertilizer have advantage and disadvantage effects on plant growth and rate on the of soil fertility (Chen, 2008). Nano-fertilizers

provide Nano structure nutrients control and increase the availability of nutrients, reduce soil toxicity and decrease the costs for protection environment (Sekhon, 2014; Rameshaiah *et al.*, 2015). Moreover, it is requisite a new way for fertilization to increase plant product. Nanotechnology has been illustrated as concerning to materials, processes and systems which work at a size of 100nm or less, and it could be used in several stages of agricultural yields production from cultivation to storage. However, use as a source of determination plant infection and controlling disease, which is one of the most critical usage of nano technology, which enhances the capability of plants to assimilate these nutrients (Mousavi and Rezai 2011; Srilatha, 2011; Ditta 2012).

Amirnia *et al.*, (2014) indicated that foliar spraying of plant with (Fe, P, K) nano-fertilizers had significantly influence on saffron (*Crocus sativus*) growth which increased flower fresh and dry weights, stigma length and total yield. Merghany *et al.*, (2019) studied the influence of liquid nano-fertilizer (3, 4.5, 6 and 9 ml) on growth and yield cucumber which cause significant increase in number of leaves.plant^{-1}, plant height, Chlorophyll pigment, N, P, K% content in leaves, fruits and yield in comparison to control. Foliar application with nano-fertilizer-NPK in chickpea increased the yield and yield components as a result of increased growth hormone activity and improved of metabolic action, caused to rise in flowering and productivity (Drostkar *et al.*, 2016).

The current experiment was purposed to assess the impact of nano-NPK on vegetative growth, production quantity and quality and to minimize the production cost of Broad bean and attempt to participate the reducing the chemical fertilizers pollutants and preserve the environment.

2-Material and methods

2-1 Location

A research was investigated in field during the winter-spring season (1st December 2019 to 30th April 2020), at Grdarasha field, collage of agricultural Engineering sciences at Salahaddin University, Kurdistan Region. Some properties of soil (physical and chemical) of field and the metrological data during the study period are shown in tables (1) and (2) respectively.

2-2 Preparing of field experiment:

1-Horticultural Practices:

The field was prepared at November 15th 2019 and divided to three blocks each consists of (10) experimental units (plots) with two rows (100 cm in length and the distance of 50 cm between them), with five plants per row and with 20 cm interval between plants (Hussein and Badshah, 2002). The experiment was ended at April 30th 2020 by harvesting green immature seeds.

2-Preparation of Nano NPK solutions

The Nano-NPK fertilizer was prepared with five levels (0, 30, 60, 90, and 120 mg. l^{-1} distill water) and was manufactured by the Iranian company (Khazra NPK Chelated Fertilizer chemical powder (20% - 20% - 20%) of Nano NPK). Those solutions were sprayed once and twice during the experiment period starting in January 25th 2020 with 30 days interval according to their treatments.

2-3 The experiment parameters:

The following parameters were measured at the end of the study: 1- Vegetative growth parameters include; Plant height, Number of leaves and Number of branches.plant^{-1}, fresh and dry weights of vegetative growth.

2- Yield parameters which include Number of pods.plant^{-1}, Number of seed.pod^{-1}, fresh weight of individual pod, fresh weight of 100 seed (g), yield.kg.plot^{-1}, yield. kg. ha^{-1}, total soluble solid in the seeds (TSS%) (AOAC, 1990), and total chlorophyll content (SPAD) (Incesu, 2015).

2-4 Experimental design and statistical analysis:

The experiment are design as RCBD and consist three blocks each with 10 experiment unit; five concentration of Nano NPK fertilizer (0, 30, 60, 90, and 120 mg. L^{-1}) and were sprayed one and two times. All data average was compared by (Duncan's Multiple Range Test) at the level of 0.05 (Al-Rawi and Khalaf-Alla, 2000) using software program SPSS (Casanova *et al.*, 2004).

3- Results and Discussion:

3.1 Vegetative parameter:

1- Effect of number of foliar application:

The results in figure (1, a and b) show significant increase of twice foliar application of Nano-NPK in most vegetative growth parameters. Except plant plant height when the longest plant

(109.244cm) was recorded from once foliar application. However, the best values of number of leaves.plant^{-1}, number of branches.plant^{-1}, chlorophyll content in leaves%, dry matter of leaves% (334.416, 5.381, 46.949 % and 22.789 % respectively) were obtained at the twice foliar application of Nano-NPK. The results are agree with Elshamy *et al.,* (2019), and may be due to the impact of nano fertilizer which raise the available nutrient to plants which increase the the formation of chlorophyll pigment, photosynthesis process as a result enhance the vegetative growth parameter generally (Al-Juthery *et al.,* 2018).

2- Effect of Nano- NPK levels:

Results in table (3) indicated that the effects of foliar application with Nano-NPK levels had significant difference on vegetative parameter compared with control treatment. The best values of plant height number of leaves.plant^{-1}, number of branches plant^{-1}, chlorophyll content in leaves, dry matter of leaves and TSS, which are (131.448 cm, 365.995, 6.120, 51.592%, 25.435% and 16.107% respectively) were recorded from foliar application with 120 mg.l^{-1} of Nano-NPK. This finding is agreed with results mentioned previously by (Merghany *et al.,* 2019). the obtained results could be due to the physiological role of nitrogen in bimolecular compound such porphyrin that exist in metabolism process such as cytochrome and chlorophyll pigment, which the necessary in respiration and photosynthesis and coenzymes that promote by phosphorus and essential for most of enzyme and amino acid production that usage for production of protein (Espinosa *et al.,* 1999), however , potassium are responsible on enzyme activity and stable of protein (Hansch and Mendel, 2009).

3- Interaction effects of number of foliar application and Nano- NPK levels:

The present result in table (4) indicated the interaction of number of foliage spraying and levels of Nano-NPK caused significant effects on all the growth parameters when compare without spraying with Nano- NPK (control) . The highest value of plant height (142.887cm) was obtained from once foliar application of 120 mg.l^{-1}of Nano-NPK. However, the best values of number of leaves.plant^{-1}, number of branches.plant^{-1}, chlorophyll content in leaves %, dry matter of leaves and TSS % (369.670, 6.513, 52.807, 25.747 and 16.290 respectively) were recorded from twice foliar application with 120 mg.l^{-1}. These results are sympathy with those obtained by (Aziz *et al.,* 2016), this can be due to the part of Nano-fertilizer in raising the diffusion of undissolved nutrients within the soil and decrease stabilization and soil biology which cause increment effective absorption of material added (Veronica *et al.,* 2015).

3.2 Yield and Yield Parameter:

1. Effect of number of foliar application:

Figure (2, a and b) presents the effect of foliar application with Nano-NPK on yield and yield component parameters of *Vicia faba* L., it can be seen that the levels of Nano-NPK had significant effect on all parameters. The best values of number of pod.plant-1, pod length, pod weight.plant-1, pod.yield-1, number of seed.pod-1, seed yield.plant-1, seed yield.ha-1 and weight of 100 seed (10.404, 20.943cm, 29.033gm, 309.494ton, 4.340, 122.013 and 250.850g respectively) were recorded from twice foliar application. These results are corresponded with that report by Kobraee et al., (2011). The raising in vegetative growth parameter that mentioned before and thus raise the photosynthesis process efficiency by high utilization of Nano particles then lead to increasing the productivity in the source then increasing the accumulation of dry substance in sinks, and increasing of yield parameters (Liu and Lal, 2015).

2- Effect of Nano- NPK levels:

The effect of foliar application Nano- NPK concentrations on yield and yield component of *Vicia faba* L. are displays in table (5).There were significant differences in all yield and yield parameters. The best values of number of pod.plant^{-1}, pod length, individual pod weight, pod.yield^{-1}, pod yield.plant^{-1}, number of seed.pod^{-1} seed yield.plant^{-1} seed yield.ha^{-1} and weight of 100 seed (11.960, 23.412cm, 30.982g, 372.935g, 37.293 ton, 5.300, 169.725g, 16.972g and 288.200g respectively) were obtained from 120 mg.l^{-1} Nano-NPK. These results are line with discovering of Drostkar *et al.,* (2016), and the possible reason may be due to increasing the

micronutrients in plant action such as photosynthesis and enhancing the advantage function of plant hormones and caused a positive reflection on the number of flowering and seed formation which ordinary increase yield component (Quary *et al.*, 2006).

3- Interaction effects of number of foliar application and Nano- NPK levels:

The present results have indicated that yield and yield component were significantly increased by number of foliar application and levels of Nano-NPK (Table 6). The best values of number of pod.plant^{-1}, pod length, individual pod weight, pod.yield^{-1}, pod yield.plant^{-1}, number of seed.pod^{-1} seed yield.plant^{-1} seed yield.ha^{-1} and weight of 100 seed (12.780, 5.600, 201.110g, 23.510cm, 33.900g, 433.240g, 307.690g respectively). were recorded from twice foliar application and 120mg.l^{-1} of Nano-NPK. This result was similar to investigation that showed by (Mohsen *et al.*, 2020).Could be due to the effect of nitrogen which play essential role in vegetative growth, production because it is a major component of chlorophyll and protein (Sandhu *et al.*, 2014).

4- Conclusion:

The findings of this study on *Vicia faba L.* demonstrate the following conclusions:

1- Twice foliar application with Nano NPK increased the values of studied Vegetative growth and yield parameters.

2- The use of (120mg.l^{-1}) Nano- NPK. significantly promoted the most vegetative growth and yield parameters.

3- The best values of vegetative growth and yield parameter were obtained from twice foliar application and (120mg.l^{-1}) of Nano- NPK.

These findings are of great interest to use Nano-NPK fertilizer, and it can produce significantly higher yield of broad bean, and can facility to be adopted by farmers for increasing the production of green pods of this plant.

Table (1): Physical and chemical properties of field*:

Soil Texture			pH	EC (dsm^{-1})	Organic matter (%)	Total Nitrogen (%)	Total Phosphorus (%)	Total Potassium (%)
Silty Clay Loam			7.65	2.36	1.134	0.137	0.000558	0.440
Sand (%)	Silt (%)	Clay (%)						
11.7	41.8	46.5						

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Table (2): Some metrological data recorded during experiment period*:

Months	Temperature (C◦)		Humidity (%)		Rainfall (mm)
	Min.	Max.	Min.	Max.	
Nov. 2019	10.73	23.39	20.57	49.99	45.262
Dec. 2019	7.96	16.42	46.58	82.16	47.03
Jan. 2020	5.20	13.14	45.62	82.97	50.774
Feb.2020	6.05	14.09	42.23	81.59	58.479
Mar.2020	10.70	20.54	38.50	77.00	61.175
Apr.2020	13.01	24.80	32.24	75.01	49.129
Total annual rainfall					311.849 mm

***** Ministry of Agriculture in Kurdistan region.

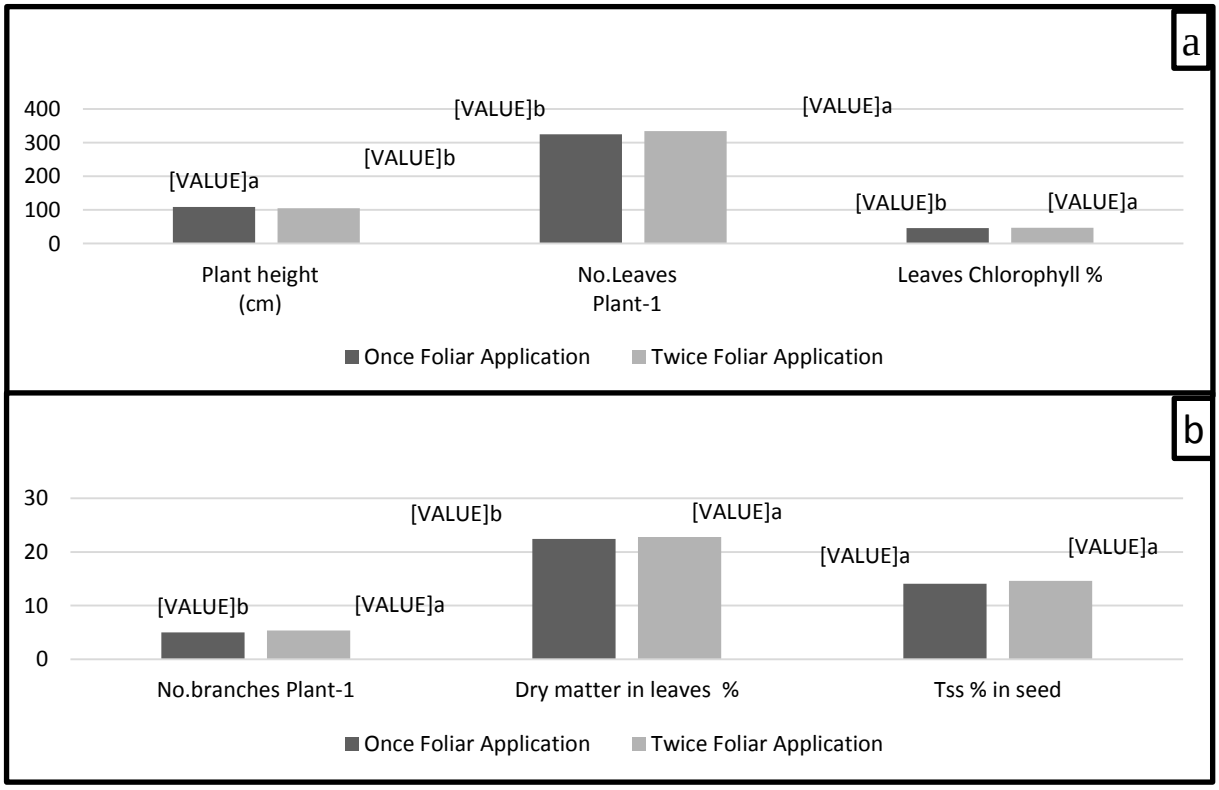

Figure (1, a and b) Effects of number of foliar application on vegetative growth parameters of *Vicia faba* L .
*(columns with the different letter are significantly different from each other depended to DMRT at 0.05 level).

Table (3) Effect of Nano NPK levels on vegetative growth parameters of *Vicia faba* L .

Con.Nano NPK mg\L	Plant.height (cm)	No.Leaves Plant^{-1}	No.branches Plant^{-1}	Chlorophyll content in leaves %	Dry matter in leaves %	Tss % in seed
0.0	90.398 c	270.788 e	4.137 e	38.855 d	21.188 c	11.055 d
30	94.920 bc	309.043 d	5.370 c	46.253 c	21.030 c	14.492 c
60	117.832 ab	355.853 b	5.817 b	48.807 b	24.708 b	15.553 b
90	100.965 bc	345.392 c	4.465 d	46.252 c	20.680 d	14.482 c
120	131.448 a	365.995 a	6.120 a	51.592 a	25.435 a	16.107 a

Data within each column followed with the different latters are indicate significantly different from each other depending to DMRT at the 0.05 level.

Table (4) Interaction effect of foliar application numbers and levels of Nano- NPK on vegetative growth parameter of *Vicia faba* L .

Application treatment	Conc. of Nano NPK	Plant.height (cm)	No.Leaves Plant^{-1}	No.branches . plant^{-1}	Chlorophyll content in leaves %	Dry matter in leaves %	TSS % in seed
Once Foliar Application	**0.0**	91.147 **b**	271.213 **g**	4.110 **f**	39.647 **f**	21.117 **e**	11.090 **g**
	30	95.583 **b**	292.597 **f**	5.120 **d**	45.070 **e**	19.980 **f**	13.983 **f**
	60	115.247 **ab**	351.677 **c**	5.633 **c**	48.377 **cd**	24.540 **c**	15.053 **c**
	90	101.367 **b**	344.257 **d**	4.323 **f**	45.303 **e**	21.380 **e**	14.333 **e**
	120	142.887 **a**	362.320 **b**	5.727 **c**	50.377 **b**	25.123 **b**	15.923 **b**
Twice Foliar Application	**0.0**	89.650 **b**	270.363 **g**	4.163 **f**	38.063 **g**	21.260 **e**	11.020 **g**
	30	94.257 **b**	325.490 **e**	5.620 **c**	47.437 **d**	22.080 **d**	15.000 **c**
	60	120.427 **ab**	360.030 **b**	6.000 **b**	49.237 **bc**	24.877 **bc**	16.053 **b**
	90	100.563 **b**	346.527 **d**	4.6107 **e**	47.200 **d**	19.980 **f**	14.630 **d**
	120	120.010 **ab**	369.670 **a**	6.513 **a**	52.807 **a**	25.747 **a**	16.290 **a**

Data within each column followed with the different latters are indicate significantly different from each other depending to DMRT at the 0.05 level.

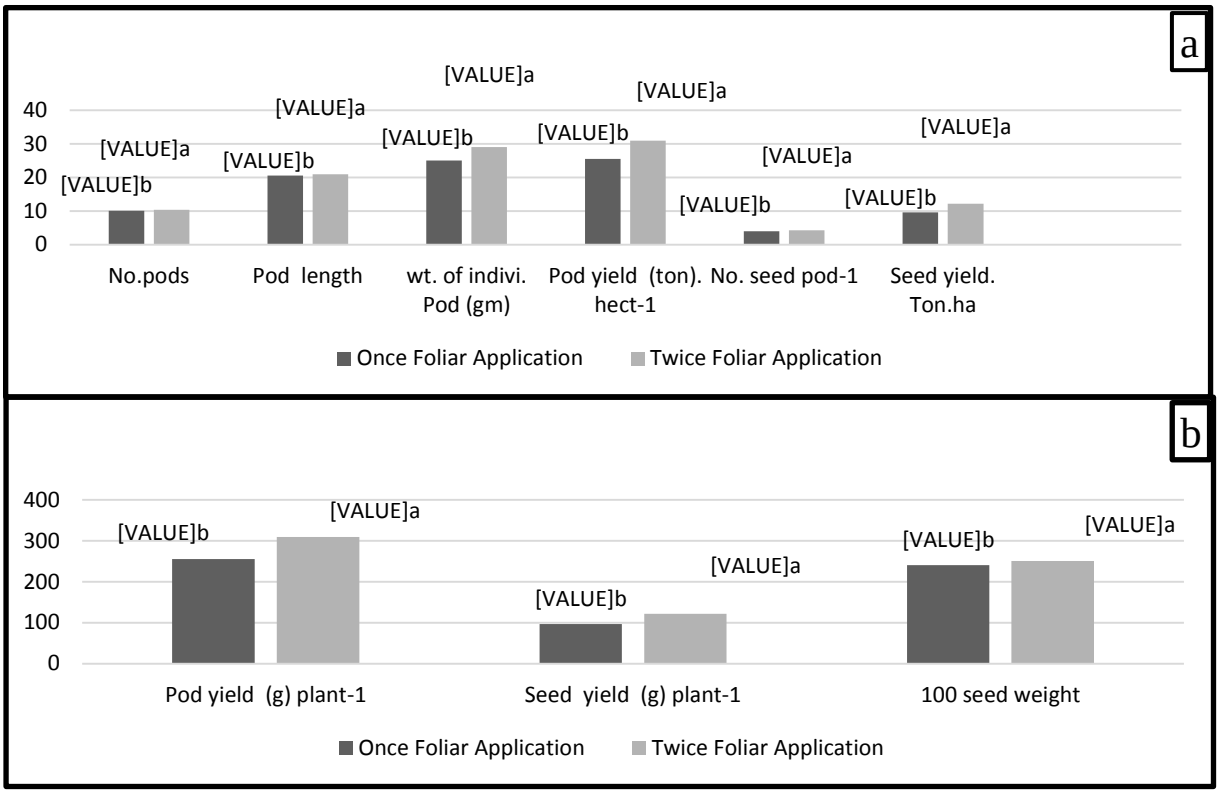

Figure (2, a and b) Effects of number of foliar application on yield and yield parameters of *Vicia faba* L .
*(columns with the different letter are significantly different from each other depended to DMRT at 0.05 level).

Table (5) Effect of Nano NPK levels on yield and yield components of *Vicia faba* L .

Con Nano.NPK mg.l^{-1}	No.pods plant^{-1}	Pod length cm	Indivi. pod weight (gm)	Pod yield (g) plant^{-1}	Pod yield (ton). hect^{-1}	No. seed pod^{-1}	Seed yield (g) plant^{-1}	Seed yield ton. ha^{-1}	100 seed weight (g)
0.0	8.585 **d**	17.108 **e**	19.383 **e**	166.007**e**	16.572 **e**	3.050 **e**	56.560 **e**	5.656e	188.892 **e**
30	9.112 **d**	19.230 **d**	24.517 **d**	223.635 **d**	22.365 **d**	3.817 **d**	84.937**d**	8.493d	232.747**d**
60	11.078 **b**	22.563 **b**	30.540 **b**	338.243 **b**	33.823 **b**	4.650 **b**	130.697 **b**	13.069b	266.260 **b**
90	10.475 **c**	21.415 **c**	29.767**c**	312.190 **c**	31.220 **c**	4.217 **c**	104.167**c**	10.416c	252.182 **c**
120	11.960 **a**	23.412 **a**	30.982 **a**	372.935 **a**	37.293 **a**	5.300**a**	169.725 **a**	16.972a	288.200 **a**

Data within each column followed with the different latters are indicate significantly different from each other depending to DMRT at the 0.05 level.

Table (6) Interaction effect of foliar application numbers and levels of Nano- NPK on yield and yield components of *Vicia faba* L .

treatment	Conc.of Nano NPK (ml.l $^{-1}$)	No.pods plant-	Pod length Cm	Pod weight (g) plant^{-1}	Pod yield (g) plant^{-1}	Pod yield (ton). hect^{-1}	No. seed pod-1	Seed yield (g) plant^{-1}	Seed yeild ton . ha^{-1}	100 seed weight (g)
Once Foliar Application	0.0	8.957 de	16.997 h	18.500 h	165.617 h	16.503 h	3.000 e	54.500 f	5.453 f	188.883 f
	30	8.950 de	18.577 g	22.833 f	204.317 g	20.433 g	3.900 d	74.560 e	7.453e	231.000 e
	60	11.080 bc	22.237 c	28.013 d	310.390 d	31.037 d	4.300 c	120.353 c	12.036c	265.333 b
	90	10.273 c	21.617 d	27.800 d	285.597 e	28.563 e	4.167 c	94.350 d	9.433 d	248.383 d
	120	11.140 b	23.313 a	28.063 d	312.630 d	31.263 d	5.000 b	138.340 b	13.836 b	268.710 b
Twice Foliar Application	0.0	8.213 e	17.220 h	20.267 g	166.397 h	16.640 h	3.100 e	58.620 f	5.860 f	188.900 f
	30	9.273 d	19.883 f	26.200 e	242.953 f	24.297 f	3.733 d	95.313 d	9.533d	234.493 e
	60	11.077 bc	22.890 b	33.067 b	366.097 b	36.610 b	5.000 b	141.040 b	14.106 b	267.187 b
	90	10.677 bc	21.213 e	31.733 c	338.783 c	33.877 c	4.267 c	113.983 c	11.403 c	255.980 c
	120	12.780 a	23.510 a	33.900 a	433.240 a	43.323 a	5.600 a	201.110 a	20.110a	307.690 a

Data within each column followed with the different latters are indicate significantly different from each other depending to DMRT at the 0.05 level.

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