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ALLELOPATHIC EFFECTS OF AQUEOUS LEAF EXTRACTS OF DATURA ON GROWTH AND YIELD OF LENTIL

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ABSTRACT

The experiment was conducted at Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, Bangladesh, during the period of December, 2018 to March 2019 to investigate allelopathic effects of aqueous leaf extracts of datura on growth and yield of lentil". Two lentil varieties (BARI mashur-3, considered as V1 and BARI mashur-6, considered as V2) and three datura leaf extract treatments (No application of datura leaf extracts, T0; 50% of datura leaf extracts spray solution, T1 and 100% of datura leaf extracts spray solution, T2) were used. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The research result revealed that BARI masur-6 produced higher plant height (60.13cm), total dry matter (15.04 g plant^{-1}) and yield contributing characters such as, pod plant^{-1}(38.56), number of seeds pod^{-1}(1.99), 1000-grain weight (25.04g), grain yield (1294.53kg ha^{-1}), stover yield (5976.70kg ha^{-1}) and biological yield (7271.23kg ha^{-1}). In case of BARI masur-3, the corresponding values were 55.67cm, 12.56g plant^{-1}, 25.20, 1.85, 22.54g, 1095.91 kg ha^{-1}, 4522.14 kg ha^{-1}, 5618.05 kg ha^{-1} respectively. Different growth parameters as well as yield components and yield of lentil negatively influenced by datura leaf extract treatment. The highest pod plant^{-1} (38.52), number of seeds pod^{-1}(2.16), 1000-grain weight (25.22g), grain yield (13.03.68kg ha^{-1}), stover yield (6345.32kg ha^{-1}), biological yield (7648.99kg ha^{-1}) were observed in T0 while the lowest corresponding values of 26.50, 1.72, 21.84g, 1072.65 kg ha^{-1},4020.05 kg ha^{-1} and 5092.70 kg ha^{-1} respectively were observed in T2. Datura leaf extracts also reduce weed infestation in the lentil field. From the result of the present study, it can be concluded that datura leaf extract can effectively control weed biomass but it showed some negative allelopathic effect on growth, yield components and yield of lentil.

INTRODUCTION

The term allelopathy, originated from the Greek word 'allelon' meaning 'each other' and 'pathos' meaning 'suffering' (Rizvi *et al.* 1992). Opined that allelopathy refers to any direct or indirect effect of plants on other plants through the release of chemicals and plays an important role in many agro-ecosystems. Allelopathic compounds may be released into the environment from plants by

means of leaf, root exudation, leaching, volatilization and decomposition of plant residues in the soil (Khalaj *et al* .2013). Allelopathic substances, if present in crop varieties, may reduce the need for weed management, particularly herbicide use (Graneli and Johansson, 2003). Allelopathy alone may not be a perfect weed management technology but it may be a supplementary tool for weed control (Singh *et al*., 2003). It is extremely difficult to demonstrate allelopathy in nature because of the complexity of plant interference which includes positive, negative and neutral effects on each other (Inderjit and Nilsen, 2003).

Alleopathy research has been conducted for several decades, but very limited knowledge is still available. An improvement in crop cultivars is the only area that has not been exploited to any great extent as a weed management strategy (Belz, 2007). Chemicals that impose allelopathic influences are called allelochemicals or allelochemics and a number of previous reports has claimed the potential use of those as herbicides. (Putnam and Duke, 1974) listed 6 classes of allelochemicals namely alkaloids, benzoxazinones, cinnamic acid derivatives, cyanogenic compounds, ethylene and other seed germination stimulants, and flavonoids which had been isolated from over 30 families of terrestrial and aquatic plants. All these chemicals possess actual or potential phytotoxicity. Now a day, thousands of secondary metabolic substances has been identified, but only a limited number has been recognized as allelochemicals. Rainfall may cause the leaching of allelopathic substances from leaves which fall to the ground and may cause inhibition of growth and germination of other crop plants (Benyas *et al*. 2010). Selection of allelopathic plants is a good and commonly used approach for identification of plants with biologically active natural products (Duke *et al.* 2000).

Daturametel L. is a genus of nine species of poisonous vespertine flowering plants belonging to the family Solanaceae.It is a one kind of annual toxicweedpopular for its allelopathic effects on different crops. Theallelopathic potentials of datura on different crops as well on weeds are largely unknown.

The lentil (*Lens culinaris L*) is an edible pulse/bean. It is a bushy annual plant of the legume family, grown for its lens-shaped seeds. Lentils contain sufficient levels of all essential amino acids, including methionine and cysteine (Iqbal et *al.*, 2006). Lentils also contain dietary fiber, folate, vitamin B_1, and minerals. Weed infestation is one of the major causes for low yield of lentil. The climate as well as the edaphic conditions of Bangladesh is favorable for the successful growth of weeds. To obtain maximum lentil yield, weeds should be controlled at proper time in right way (Chaudhary *et al*.2011). Leaf extracts of Daturais considered as a natural weedicide. It reduces the weed growth and kill the noxious weeds (Elisante *et al*.2014). It has no any harmful effect which reduce the soil fertility while many chemical weedicides has been reported to reduce the soil fertility and pollutes our environment. However, the possible application of allelopathy in agriculture is the subject of much research. Sometime allelopathic action may be caused yield loss. Current research was focused on the effects datura leaf extracts on lentil growth and yield as well as weed infestation in the experimental field. This research furthers aims to study on the possibility of using allelochemicals as growth regulators and natural herbicides, to promote sustainaible agriculture.

PLANT MATERIALS AND GROWTH CONDITION:

The experiment was conducted at Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, Rajshahi University, Rajshahi, during the period December 2018 to March 2019. The experimental field was situated at the western side of Agronomy and Agricultural Extension Department. Geographically the experimental field was located at $24^0$22'36" N latitude and $88^0$38' 36"E longitude at an elevation of 20m above the sea level belonging to the agro ecological

zone 11 (AEZ-11)**.** The experimental field was situated on a high land with sandy loam textured soil having pHvalue of 8.1. Seeds of both lentil varieties (BARI Masur-3 and BARI Masur-6) were collected from Regional Bangladesh Agricultural Development Corporation (BADC) Research Station, Rajshahi.

Experimental Treatments: The experiment consists of two lentil varieties i.e. (BARI mashur-3; V_1 and BARI mashur-6; V_2) and three *Datura metel L.* leafextract treatments i.e. T_0= no treatment or spraying with only distilled water (control), T_1= 50% of *Datura*leafextract spray solution and T_2= 100% of *Datura*leafextract spray solution. The experiment was laid out in a Randomized Complete Block Design with three replications. The total number of unit plots in the entire experimental was 18. The unit plot size was $5m^2$ (2.5m×2m).

Preparation of Spray Material: Fresh leaves of *Datura metel L.* were collected from Meherchandi, Rajshahi. Immediately after collection, the leaves were thoroughly washed with tap water, followed by sterilized water. After removing additional water, 100g fresh leaf was blended with 100 ml of distilled water. These were filtered through a muslin cloth followed by Whatmann no.1filter paper to prepare 100% spray solution. The solution was further diluted with 50ml distilled water to get 50% spray solution. The spray solutions were sprayed in the experimental field by using hand sprayer according to the treatment layout. Control plots were sprayed with same amount of distilled water.

Water extract of*Datura*leaf was sprayed to the lentil plants homogeneously at 21 and 42 DAS.

Crop cultivation and agronomic management: Power tiller was used for the preparation of experimental field. All the weeds and stubbles were removed from the experimental field. The plots were spaded one day before planting and the basal fertilizers were incorporated thoroughly before planting according to fertilizer recommendation guide (BARC, 1997). The soil was treated with insecticides at the time of final ploughing. Insecticides Furadan 5G was used @ 8 kg ha^{-1} to protect young plants from the attack of mole cricket, ants, and cutworms. One third of urea (50 kg ha^{-1}) along with whole TSP (85 kg ha^{-1}) , MoP (35 kg ha^{-1})and Gypsum (45 kg ha^{-1})were applied during final land preparation. The remaining half of urea was top dressed at first irrigation (22 DAS) and least one third of urea was applied at 2^{nd} irrigation at 50 DAS.

Seeds of BARI masur-3 and BARI masur-6 varieties were hand sown in the experimental plot. Seeds were sown on 2^{nd} December 2018. The row to row and plant to plant distances were 25 and 4 cm, respectively. Seeds were placed at about 5 cm depth from the soil surface. Emergences of seedlings were completed within 10 days after sowing. Overcrowded seedlings were thinned out two times.

The field was observed time to time to detect visual difference among the treatments and any kind of disease infestation. The experimental crop was not infected with any disease and no fungicide was used. Crop was harvested plot wise at 120 DAS when about 80% of the pods attained maturity. Data were recorded on $1m^2$ area of the middle portion of each plot. The harvested plants of each treatment were brought to the cleaned threshing floor and separated pods from pants by hand and allowed them for drying well under bright sunlight. After threshing, grain yields and stover yields of each plot were recorded separately. At final harvest, data on some growth parameters were also collected.

Statistical Procedure: The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjudged with Duncan's Multiple Range Test (DMRT) using the statistical computer package program, STATVIEW (Gomez and Gomez, 1984)

RESULTS

During our study growth, yield contributing characters and yield of lentil varieties were subjected to datura leaf extract application were evaluated. Plant height of lentil was measured on 21, 42,63and84days after sowing (DAS) are presented in Table 1. At 21 DAS, the tallest plants (12.22cm) were found in BARI masur-3 (V_1) and the shortest one(11.89cm) was recorded in BARI masur-6 (V_2). At 42 DAS, the tallest plant (35.99cm) was recorded in V_2 and which was significantly 15.68% higher than V_1. At 63 DAS, a remarkable higher value in plant height was observed in V_2 (57.64cm) which was8.32% higher thanV_1.Finally at 84DAS, the tallest plants (60.13cm) were also recorded inV_2which was significantly 8.01% higher thanV_1.

The allelopathiceffects of daturaleaf extracts on plant height of lentil was marginal at 21 DAS but it varied significantly at 42,63 and 84DAS (Table 2).At 21 DAS,the highest plant height (12.69cm) was observed in T_1(50% of datura leaf extracts spray solution) and the plant height (11.60cm) was obtained inT_0 (no application of datura leaf extracts or(control).At 42 DAS,the highest plant height (35.56cm) was observed inT_0 which reduced slightly 5.70%in T_1 and significantly by 11.22% inT_2(100% of datura leaf extracts spray solution).At 63 DAS,the highest plant height (57.86cm)was observed in T_0 which reduced only 3.59% in$T_1$and significantly by 9.05% inT_2.At 84 DAS,the highest plant height (60.76cm) was observed inT_0 which reduced significantly by 4.89% and 9.23% in$T_1$and T_2 respectively.

Plant height of lentil was statistically significant due to interaction between varieties and datura leaf extracts at all observations (42,63 and 84 DAS) except 21 DAS (Table 3). At 21 DAS, the highest plant height(12.76cm) was observed in the interaction ofV_1withT_1 and the lowest plant height (11.22cm) was found in the interaction of V_2 with T_0. At 42 DAS, the highest plant height (37.53 cm) was found in the combination of$V_2$with T_0 and the lowest (29.13cm) was in V_1withT_2.At 63 DAS, the highest plant height (59.93 cm) was obtained from $V_2$with T_0 and the lowest (50.73 cm) was observed in the interaction of V_1withT_2.At 84 DAS, the highest plant height(62.58cm) was found in the combination of $V_2$with T_0 and the lowest plant height(52.91cm) was observed in the interaction of V_1withT_2.

Both lentil varieties differed significantly in respect to number of branches per plant at harvest. The highest number of branches per plant (27.34) was observed in V_2which was 3.21% higher than V_1(Table 2). Significant differences were observed in number of branches per lentil plant for spraying leaf extracts of datura (Table 2). The highest number of branches per plant (27.91) was recorded in T_0which reduced only 2.93% in T_1andsignificantly by 7.91% inT_2.Significant interaction between varieties and spraying leaf extracts of datura were observed in number of branches per lentil plant at harvest (Table 2). Maximum number of branches per plant at the harvest was recorded in the combination of $V_2$with T_0(28.42) and the lowest (25.32) was found in V_1T_2.

Both lentil varieties differed significantly in respect to number of pods per plant. The highest number of pods per plant (38.56) was observed in V_2which was 34.64%higher thanV_1(Table 2). Significant differences were observed in number of pods per lentil plant for spraying leaf extracts of datura(Table 2). The highest number of pods per plant (38.52) was recorded in T_0which reduced significantly by 20.50% and 31.20% in T_1andT_2respectively.Significant interactions between varieties and spraying leaf extracts of datura were observed in number of pods per plant of lentil (Table 2). Maximum number of pods per plant (42.63) was recorded in the combination of $V_2$with T_0 and the minimum (18.73) was found in V_1T_2.

Both lentil varieties differed significantly in respect to number of effective pods per plant. The highest number of effective pods per plant (36.76) was observed in V_2which was 36.23% higher than that in

V_1(Table 2). Significant differences were observed in number of effective pods per lentilplant for spraying leaf extracts of datura (Table 2). The highest number of effective pods per plant (36.68) was recorded in T_0which reduced significantly by 21.40% and 32.44% in T_1andT_2 respectively. Significant interaction between varieties and spraying leaf extracts of datura were observed in number of effective pods per plantof lentil (Table 2). Maximum number of effective pods per plant (40.77) was recorded in the combination of $V_2$with T_0 and the minimum number (17.03) was found inV_1T_2.

Significant difference was observed in number of seeds pod^{-1} between two lentil varieties. The highest number of seeds pod^{-1}(1.99) was observed from V_2which was 7.03% higher thanV_1 (Table 2). Significant differences were observed in number of seeds pod^{-1} for spraying leaf extracts of datura. The highest number of seeds pod^{-1} (2.16) was recorded in T_0 which reduced significantly by 12.96% and 20.37% in $T_1$and T_2respectively.Significant interaction between varieties and leaf extracts of datura were observed in number of seeds pod^{-1} of lentil. Maximum number of seeds pod^{-1} (2.21) was found in the combination ofV_2 with $T_0$and the minimum (1.66) was found inV_1 with T_2.

Varieties differed significantly in 1000 grains weight of lentil (**Table 2**). The highest 1000 grain weight (25.04 g) was observed from V_2 which was 9.98% higher than V_1. Significant differences between two lentil varieties in respect to 1000 grain weight were observed for spraying leaf extracts of datura. The maximum1000 grain weight (25.22g) was recorded in T_0 which reduced only 3.60% in T_1andsignificantly by 13.40% inT_2.Significant interaction between varieties and leaf extracts of datura were observed in 1000 grains weight. Maximum 1000 grains weight (25.79 g) was found in the combination of V_2 with T_0 and the minimum (19.45 g) was observed in V_1 with T_2.

Both lentil varieties differed significantly in grain yield. The highest grain yield (1294.53 kgha^{-1}) was observed in V_2(*BARImasur-6*) which was 15.34% higher than V_1(*BARI masur-3*, **Table 2**).Grain yield showed significant differences for spraying leaf extracts of datura and the maximum grain yield (1303.68 kgha^{-1}) was recorded in T_0 which reduced only 7.23% in $T_1$and significantly by 17.72% in T_2.Significant interaction was found between varieties and leaf extracts of datura in grain yield of lentil.Maximum grain yield (1417.14kgha^{-1}) was observed in the combination of V_2 with T_0 and minimum (1003.56kgha^{-1}) was observed in V_1 with T_2.

There were significant differences found between two lentil varieties in stoveryield (Table 2). Maximumstover yield (5976.70kgha^{-1}) was observed in V_2which was (24.34%) higher than V_1. Stover yield showed significant differences due to spraying leaf extracts of datura. The maximum stover yield (6345.32kgha^{-1}) was recorded in T_0which reduced 15.17%in T_1and36.65% in T_2. Significant interaction was found between varieties and spraying leaf extracts of datura on stover yield of lentil. The highest stoveryield (6603.80 kg ha^{-1}) was observed in the combination of V_2 with T_0 and the lowest (3059.65kgha^{-1}) was inV_1 with T_2.

Biological yield of lentil varieties presented in Table 2, differed significantly. Maximum biological yield (7271.23kg ha^{-1}) was observed in V_2which was 22.74%higher than that in V_1. Significant differences were observed in biological yield of lentil for spraying leaf extracts of datura. The highest biological yield (7648.99kgha^{-1}) was recorded inT_0which reduced slightly (13.81%) in T_1andsignificantly by 33.41%in T_2. Significant interaction between varieties and spraying leaf extracts of datura were observed in biological yield of lentil. The highest biological yield (8020.95kg ha^{-1}) was observed in the combination of V_2 with T_0 and lowest (4063.22kg ha^{-1}) was inV_1 with T_2.

Both lentil varieties differed non-significantly in harvest index (HI).Maximum HI (20.89%) was observed in V_1 and the minimum (18.14%) was found in V_2(Table 2).Significant differences were observed in harvest index for spraying leaf extract of datura on lentilplant and the highest harvest index (22.36%) was recorded in T_2.Significant interaction was observed between varieties and spraying leaf extracts of datura in harvest index.The maximum HI (25.82%) was observed in the combination of V_1 with $T_2$and the minimum (16.56%) was inV_1withT_0.

There were significant differences found between two varieties of lentil field in weed biomass (Figure 1). Maximum weed biomass (26.69 g) was observed in V_1 field which was (27.42%) higher than V_2 field. Weed biomass showed significant differences due to spraying leaf extracts of datura inlentil field. The maximum weed biomass (28.23 g) was recorded in T_0which reduced only 17.56% for $T_1$and significantly by 37.62% for T_2. No significant interaction was found between varieties and spraying leaf extracts of datura in weed biomass of lentil field. The highest weed biomass (32.67 g) was observed in the combination of V_1 with T_0 and the lowest (15.23 g) was in V_2 with T_2.

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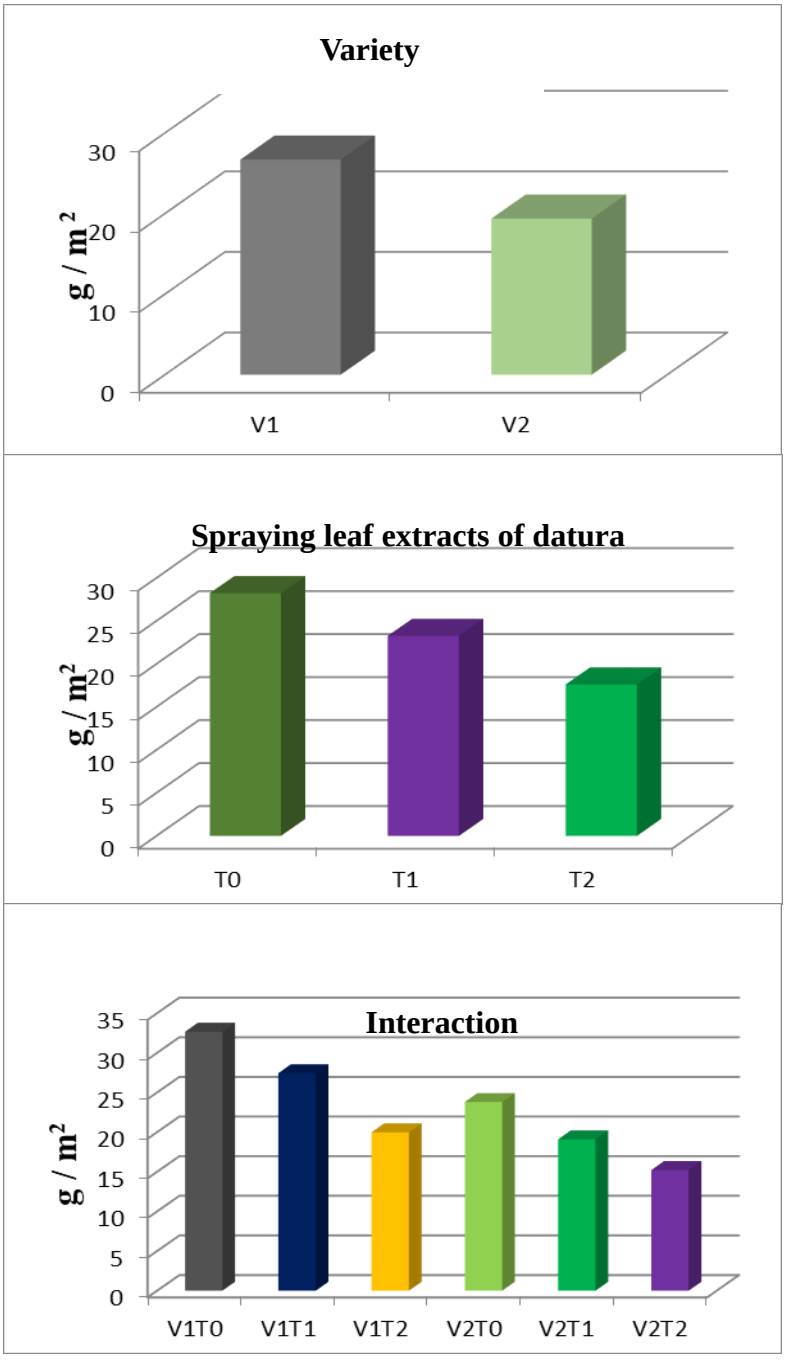

V_1= BARI masur-3, V_2= BARI masur-6, T_0= No application of datura leaf extracts, T_1= 50% of datura leaf extracts spray solution, T_2= 100% of datura leaf extracts spray solution.

Figure-1: Weed biomass in the experimental field under different experimental treatments

Table 1: Allelopathic effects of datura leaf extract on plant height of two lentil varieties at different days after sowing

Variety	Plant height(cm)			
	21 DAS	**42 DAS**	**63 DAS**	**84 DAS**
V_1	12.22 ± 0.51	31.11 ±0.82 b	53.21 ±1.04 b	55.67 ± 1.09 b
V_2	11.89 ± 0.61	35.99 ± 0.69 a	57.64 ± 1.06 a	60.13 ± 1.02 a
LS	NS	0.05	0.05	0.05
Treatment				
T_0	11.60 ± .484	35.56 ± 1.048 a	57.86 ± 1.203 a	60.76 ± 1.232 a
T_1	12.69 ± .931	33.53 ± 1.460 ab	55.78 ± 1.520 a	57.79 ± 1.440 b
T_2	11.87 ± .558	31.57 ± 1.237 b	52.62 ± 1.298 b	55.15 ± 1.252 b
LS	NS	0.05	0.05	0.05
Interaction				
V_1T_0	11.99 ± .865	33.59 ± 1.069 b	55.79 ± 1.269 ac	58.93 ± 1.60 ac
V_1T_1	12.76 ± 1.069	30.62 ± .931 c	53.10 ± 1.568 cd	55.17 ± .872 cd
V_1T_2	11.92 ± 1.041	29.13 ± .976 c	50.73 ± 1.537 d	52.91 ± 1.284 d
V_2T_0	11.22 ± .540	37.53 ± .686 a	59.93 ± 1.164 a	62.58 ± 1.303 a
V_2T_1	12.63 ± 1.786	36.44 ± 1.145 ab	58.46 ± 1.387 ab	60.42 ± 1.644 ab
V_2T_2	11.83 ± .686	34.01 ± .865 b	54.52 ± 1.570 bd	57.38 ± 1.102 bc
LS	NS	0.05	0.05	0.05
CV (%)	15.41	4.93	4.45	3.97

Mean values in a column having the same letters or without letter do not differ significantly as per Duncan's multiple range test (DMRT) , NS= Non significant, CV= Co-efficient of variation, LS= Level of significance, LSD= Least significant difference, DAS=Day's after sowing,V_1 = Variety 1 (BARI masur-3), V_2 = Variety 2 (BARI masur-6), T_0 =No application of datura leaf extracts (control),T_1 =50% of datura leaf extracts spray solution andT_2 =100% of datura leaf extracts spray solution

Table 2: Allelopathic effects of datura leaf extract on different yield components and yield of two lentil varieties

Variety	No. of branch plant^{-1}	No. of total pods plant^{-1}	No. of effective pods plant^{-1}	No. of seeds pod^{-1}	1000 grain weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
V_1	26.46 ±.366 b	25.20±2.527 b	23.44±2.511 b	1.85±.077 b	22.54±.840 b	1095.91±33.437 b	4522.14±544.666 b	5618.05±577.454 b	20.89±1.823
V_2	27.34 ±.433 a	38.56±1.620 a	36.76±1.606 a	1.99±.076 a	25.04±329 a	1294.53±47.353 a	5976.70±437.295 a	7271.23±473.524 a	18.14±.735
LS	0.05	0.01	0.01	0.05	0.01	0.01	0.05	0.05	NS
Treatment									
T_0	27.91± 0.29 a	38.52±2.204 a	36.68±2.186 a	2.16±.052 a	25.22±.377 a	1303.68±59.41 a	6345.32±485.665 a	7648.99±516.142 a	17.27±.930 b
T_1	27.09±0.47 a	30.62±3.855 b	28.83±3.849 b	1.88±.074 b	24.31± .500 a	1209.32±56.305 a	5382.90±608.120 ab	6592.22±660.429 b	18.92 ±1.22 ab
T_2	25.70± 0.29 b	26.50±3.706 b	24.78±3.697 b	1.72±.057 b	21.84 ±1.13 b	1072.65±43.408 b	4020.05 ±580.156 b	5092.70 ±621.136 b	22.36 ±2.315 a
LS	0.05	0.01	0.01	0.05	0.01	0.01	0.05	0.05	0.05
Interaction									
V_1T_0	27.39 ±.291 ab	34.40±1.762 b	32.60±1.793 b	2.10±.071 a	24.66±.543 ab	1190.22±55.361 bc	6086.83±699.224 a	7277.05±754.585 ab	16.56±1.969 b
V_1T_1	26.67±.531 bc	22.47±1.761 c	20.70±1.733 c	1.77b±.088 c	23.51±.491 b	1093.95±36.079 cd	4419.94±636.425 ab	5513.89±672.484 bc	20.29±1.889 ab
V_1T_2	25.32±.359 c	18.73±1.855 c	17.03±1.798 c	1.66±.066 c	19.45±.674 c	1003.56±18.128 d	3059.65±605.976 b	4063.22±624.089 c	25.8 ±3.693 a
V_2T_0	28.42±.274 a	42.63±2.059 a	40.77±1.997 a	2.21±.073 a	25.79±.302 a	1417.14±41.326 a	6603.80±789.697 a	8020.95±790.106 a	17.98±1.695 b
V_2T_1	27.51±.797 ab	38.77±2.190 ab	36.97±2.218 ab	1.99±.084 ab	25.10±.616 ab	1324.70±35.180 ab	6345.86±718.833 a	7670.56±752.192 ab	17.54±1.408 b
V_2T_2	26.08±.374 bc	34.2 ±2.219 b	32.53±2.247 b	1.77±.093 bc	24.23±.463 ab	1141.74±65.719 cd	4980.44±627.169 ab	6122.19±692.618 ac	18.89±1.071 b
LS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CV(%)	3.04	10.77	11.36	7.16	3.84	6.46	22.51	19.25	17.8