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USING L- TRYPTOPHAN TO INFLUENCE THE CROP GROWTH OF MAIZE AT DIFFERENT HARVESTING STAGES

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ABSTRACT

L-Tryptophan (L-TRP), a physiological precursor of Auxin, significantly affected the maize crop growth and dry matter accumulation in a laboratory experiment. The trial was conducted using completely randomized design (CRD). Four concentrations of L-TRP, 0.0025, 0.025, 0.25 and 2.5 mg kg^{-1} of soil were applied as soil drench along with a control. L-Tryptophan enhanced the leaf area plant^{-1}, shoot length and shoot dry matter. L-Tryptophan did not increase the number of leaves per plant at first harvest but it increased the leaves at second, third, fourth and fifth harvests. At the start, crop growth rate (CGR) and relative growth rate (RGR) increased with a slower pace with L-TRP from 0.0025 to 0.25 mg kg^{-1} but these increased swiftly from 0.25 to 2.5 mg kg^{-1}. Soil drenching @ 2.5 mg kg^{-1} of L-TRP produced maximum reflective effects on cell expansion, leaf area and shoot dry matter. At final harvest, L-TRP @ 2.5 mg kg^{-1} of soil caused 86.93 % increase in shoot dry matter over control. The associations of shoot dry matter with leaf area per plant, CGR and RGR were significant and linear.

Key Words: L-tryptophan, Leaf area, Dry matter, CGR, Plant growth

INTRODUCTION

L-tryptophan is distinguished to be a physiological precursor of auxin in higher plants (Ahmad *et al*., 2007). Auxin is a plant growth regulator when applied in appropriate concentrations may regulate cell elongation, induction of cambium cell division, formation of adventitious roots, axillary shoot formation, tropisms, callus initiation, growth and induction of embryogenesis (Ahmad *et al*., 2008). L-Tryptophan can significantly affect the growth of maize crop (Zahir *et al*., 2005). It has more positive effects on plant growth and yield as compared to pure auxin (Frankenberger *et al*., 1990, Frankenberger and Arshad, 1991 and Sarwar and Frankenberger 1994). Applying L-TRP to soil produces Indole-3-acetic acid, which in turn regulates plant growth and development. Soils amended with L-TRP can actively synthesize auxin (Martens and Frankenberger, 1993).

Maize (*Zea mays* L.) is one of the important cereals in the world. It occupies a very important place in the economy of Pakistan. In Pakistan, it is cultivated on an area of 1118 thousand hectares with the total annual production of 4036 thousand tons. National average yield is 3610 kg ha^{-1} (GOP, 2008-09). Although, the average yield of maize in Pakistan has increased by 118 % in comparison to that of 1999-2000 (1658 kg ha^{-1}) (Agricultural Statistics of Pakistan, 1999-2000) due to the scientific improvements owing to cultivars especially introduction of hybrids and crop production techniques yet it is still lower than the potential yield of existing varieties. Besides being important food and feed crop, it also provides raw material for the industry. It is used for the preparation of glucose, extraction of edible oil, corn flakes, custard, etc., which makes it an eminent crop among other cereals in our country.

Substantial consideration has been lacking in our agricultural research work in Pakistan regarding determining the influence of L-TRP on maize growth and development, which can evoke a physiological response with the consequences of increased nutrient uptake and hence better plant growth and development. Plant may not have the ability to synthesize sufficient endogenous plant growth regulator (PR) for optimal growth and development under suboptimal climatic and environment conditions. An exogenous supply of phyto-hormones or their precursors may affect the endogenous hormonal pattern of the plants, either by supplementation of suboptimal levels or interaction with synthesis, translocation and inactivation of existing hormone level. The present study has, therefore, been designed to appraise the influence of various levels of L-TRP on an assortment of maize crop growth characteristics, crop growth rate (CGR) and relative growth rate (RGR).

MATERIAS AND METHODS

The study was conducted to evaluate the influence of various levels of L-TRP on the growth of maize. The treatments of L-TRP were comprised of four levels viz. 2.5, 0.25, 0.025, and 0.0025 mg kg^{-1} soil along with a control. The experiment was conducted in the Agronomy laboratory, University of Arid Agriculture, Rawalpindi.

The experiment was laid out in completely randomized design (CRD) with five treatments and three replications. Stock solution was prepared by dissolving 0.225 gm of L-TRP in 1.5 liter of distilled water to have appropriate concentration of treatment solution. Stock solution was diluted ten times to have solution for second treatment. Solution used for second treatment was again diluted ten times to have a solution for third treatment, where as solution used as third treatment was diluted ten times to have a solution for fourth treatment. The plastic pots were filled with sieved loam soil having 0.75 % organic matter, 4.9 ppm available phosphorous, 0.018 % total soluble salts, 34 % saturation and 7.3 pH. Equally distant ten seeds of maize were sown in each pot. Uniform water was applied to each pot, as and when needed to avoid moisture stress. L-Tryptophan was applied as soil drench before sowing using 50 ml of required solution in each pot. The solution was injected by using a syringe. The observations on various growth parameters were recorded for five harvests. First harvest was made 10 days after sowing (DAS). Second, third, fourth and fifth harvests were made at five days interval. At each harvest, shoot length and number of leaves were recorded. Leaf area was measured with leaf area meter. The shoots from each treatment for different harvests were dried in an oven for 72 hours and weighed. CGR and RGR were determined by using the formulae given by Radford (1967) as under:

CGR = dw / dt

Where dw / dt is the change in dry weight per unit of time.

RGR = 1 / w X dw / dt

Where, dw / dt is the change in dry weight per unit of time and w is the initial plant dry weight.

The data were subjected to Fisher’s analysis of variance technique and LSD Test at 5 % probability level was applied to compare the differences among treatments means (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Significant effect of L-TRP (Fig. 1) was established for crop growth rate. The response was uniform at all the harvesting intervals (10-15 DAS, 10-20 DAS and 10-68 DAS). The maximum CGR (11.28, 14.98 and 112.0 mg plant^{-1} d^{-1}, respectively) was produced at all the three harvesting intervals when maize crop was applied L-TRP @ 2.5 mg kg^{-1} of soil. Crop growth rate increased with the increasing levels of L-TRP even the lowest level of L-TRP (0.0025 mg kg^{-1}) remained effective in enhancing the CGR as compared to control. The lowest CGR values were obtained at control. The increase in CGR may be attributed to the promoting effects of L-TRP on shoot growth, leaves / plant and leaf area expansion. These results are in line to those of Sarwar and Frankenberger (1994) who reported that L-TRP use at appropriate concentrations exhibited positive effects on crop growth.

Relative growth rate of maize crop was significantly increased with the application of L-TRP. There was progressive increase in RGR values with the increasing concentrations of L-TRP (Fig. 2). On 10-15 DAS harvesting interval, the highest RGR (167 mg mg^{-1} d^{-1}) was attained with 2.5 mg L-TRP kg^{-1} of soil. It was significantly different from all the other concentrations. The lowest RGR (119.6 mg mg^{-1} d^{-1}) was recorded with control. On 10-20 DAS, a similar trend was observed as that of 10-15 DAS; however on 10-68 DAS the highest RGR (1671 mg mg^{-1} d^{-1}) was achieved when L-TRP was applied @ 2.5 mg kg^{-1} of soil but that was statistically analogous with the values obtained at L-TRP levels of 0.25 and 0.025 mg kg^{-1} of soil. The lowest RGR (1291 mg mg^{-1} d^{-1}) was gained in control which was at par with that of 0.0025 mg kg^{-1} of soil. The rate was relatively higher on 10-20 DAS than that of 10-68 DAS. The gradual increase in RGR values with the different concentrations might be a result of differential growth effect caused by L-TRP on shoot length and leaf area that ultimately enhanced the plant dry matter.

Shoot length of maize was significantly affected by the application of different levels of L- TRP at all the harvesting times (Table-I). The highest shoot length was produced when L-TRP was applied @ 2.5 mg kg^{-1} of soil. The order of ranking of L-TRP application was the same at all the harvests whereas the application rate of 2.5 mg kg^{-1} of soil was followed by the L-TRP application rate of 0.25, 0.025, 0.0025 mg kg^{-1} of soil and control, respectively. The increase in shoot length might have been resulted from cell expansion with the use of L-TRP. The results are in corroboration with those of Arshad *et al.* (1994) and Zahir *et al*. (1998) who reported positive effects produced by different levels of L-TRP in increasing the shoot length.

L-Tryptophan did not enhance the number of leaves per plant at first harvest but it enhanced the leaves at second, third, fourth and fifth harvests (Table-I). The maximum number of leaves (11.58) per plant was achieved due to L-TRP application @ 2.5mg kg^{-1} of soil at the fifth harvest. The lowest number of leaves (2 per plant) was recorded with control at first harvest. The increased number of leaves might have been induced due to the positive response of L-TRP on the cellular division during the growth and development process.

Leaf area per plant of maize was significantly influenced at different harvesting times (Table I). At final harvest, the maximum values for leaf area per plant were achieved. All the levels of L-TRP caused a significant increase in leaf area per plant at different harvests. L-TRP application rate of 2.5 mg kg^{-1} of soil produced the maximum leaf area per plant at all the harvests. The maximum leaf area per plant (16540 sq. inches) was recorded at L-TR @ 2.5 mg kg^{-1} of soil at final harvest. The minimum leaf area (279.2 sq. in) was observed with control at first harvest. Leaf area expansion had a positive effect on crop growth and resulted in an increase in plant dry matter that may be attributed to increased light interception.

Table I. Effect of L-TRP on shoot length, leaf area per plant, number of leaves per plant and shoot dry weight

Harvest stages	L-Trp dose (mg kg^{-1} of soil)	Shoot length (cm)	No.of leaves /plant	Leaf area (sq.inch)	Leaf area (sq.cm)	Dry weight of shoot (mg $plant^{-1}$)
Harvest 1	Control	18.13 cd	2.25 NS	279.2 e	1801 e	41.75 e
	0.0025	19.32 c	2.42	311.6 d	2010 d	48.08 d
	0.025	20.65 bc	2.50	361.4 c	2331 c	52.28 c
	0.25	21.88 ab	2.50	386.2 b	2491 b	59.00 b
	2.5	23.21 a	2.25	436.3 a	2814 a	67.13 a
Harvest 2	Control	24 b	3.00 b	611.5 c	3044 c	64.67 e
	0.0025	24.31 b	3.50 a	698.5 b	4505 b	80.67 d
	0.025	28.19 a	3.50 a	752.8 ab	4856 ab	91.08 c
	0.25	30.08 a	3.50 a	781.8 a	5043 a	105.3 b
	2.5	30.67 a	3.67 a	807.8 a	5210 a	123.3 a
Harvest 3	Control	27.84 c	3.25 b	1332 b	8591 b	115.4 e
	0.0025	29.18 c	4.25 a	1489 a	9604 a	144.6 d
	.025	31.63 b	4.58 a	1532 a	9881 a	161.0 c
	.25	33.45 ab	4.67 a	1562 a	10075 a	185.7 b
	2.5	34.47 a	4.02 a	1620 a	10449 a	216.3 a
Harvest 4	Control	33.61 c	4.08 c	1398 d	9017 d	2451d
	.0025	34.43 c	4.58 bc	1592 c	10268 c	3123 c
	.025	37.02 b	4.92 ab	1667 bc	10752 bc	3650 c
	.25	38.83 a	5.25 ab	1764 ab	11378 ab	4608 b
	2.5	39.77 a	5.42 a	1905 a	12287 a	5500 a
Harvest 5	Control	7343 c	9.83 d	13170 c	84947 c	3504 d
	.0025	74.22 c	10.58 c	14960 b	96492 b	4173 c
	.025	76.05 bc	11.08 b	15520 ab	100104 ab	4700 c
	.25	78.20 b	11.33 ab	16070 ab	103652 ab	5658 b
	2.5	81.59 a	11.58 a	16540 a	106683 a	6550 a

Means with different letters within the same categories differ significantly at $P < 0.05$

The results revealed that there were significant differences in dry weight of shoot at different harvests (Table I). Different levels of L-TRP caused a significant increase in shoot dry weight. At all the harvests, the shoot dry matter increased with the increasing levels of L-TRP. The L-TRP application rate of 2.5 mg kg^{-1} of soil produced the maximum dry weight of shoot at all harvests. The minimum shoot dry weight (41.75 mg $plant^{-1}$) was observed with the control at first harvest. The mximum shoot dry weight (6550 mg $plant^{-1}$) was recorded with 2.5 mg L-TRP kg^{-1} of soil at fifth harvest. At final harvest, L-TRP @ 2.5 mg kg^{-1} of soil caused 86.93 % increase in shoot dry matter over control. These findings are in consistency with those of Frankenberger *et al*. (1990) and Shahzad (1993) who reported increase in dry weight of shoot examined with the increase in L-TRP concentrations. Zahir *et al*., (2005) has also described the significant influence caused by L-TRP on maize growth and yield. These results are in partial consistency with those of Ahmad *et al*. (2008) who determined that L-TRP treated nitrogen enriched compost (NEC) increased total biomass and cob yield. The association of shoot dry matter with leaf area per plant (Fig.3) was significant and positive. The data indicated 85.16 % of variability in shoot dry matter due to leaf area. Correlation between leaf area and shoot dry matter showed a slope of 0.85 mg $plant^{-1}$ was produced for each sq. inch increase in leaf area. There were positive and linear correlations between CGR and shoot dry matter (Fig. 4) and similarly between RGR and shoot dry matter (Fig. 5). The increase in shoot dry matter by applying L-TRP may be attributed to increase in cell expansion, leaves and leaf area per plant that resulted in the enhanced CGR and RGR (Ahmad *et al*., 2008). Radiation-use efficiency might have been enhanced due to leaf area expansion by L-TRP. It may be very likely that the physiological response induced is due to the presence of auxins produced in the rhizosphere of maize as a result of the upshot of precursor L-Tryptophan.

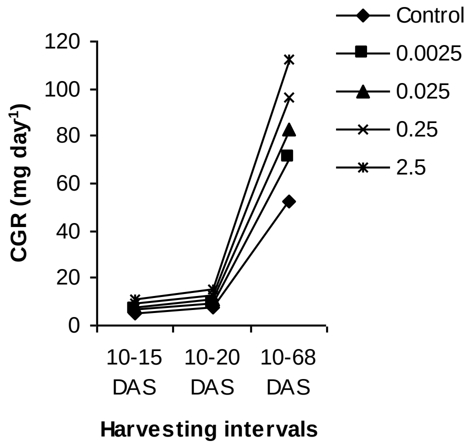

Fig. 1: CGR as affected by L-TRP at different harvesting intervals

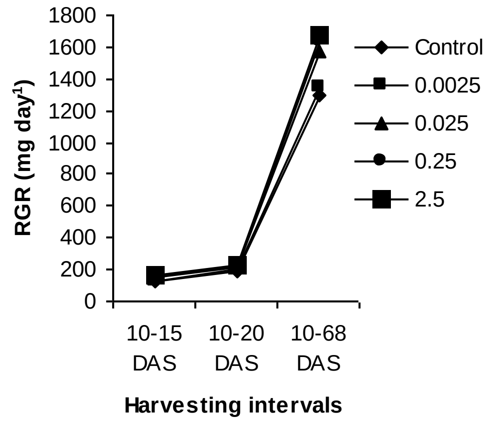

Fig. 2: RGR as affected by L-TRP at different harvesting intervals

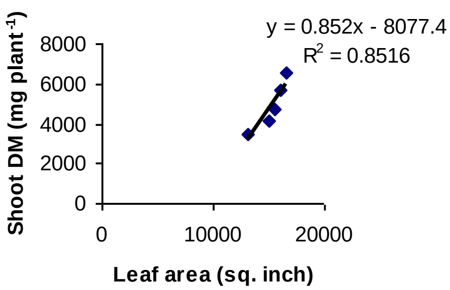

Fig. 3: Correlation between leaf area and dry matter of shoot

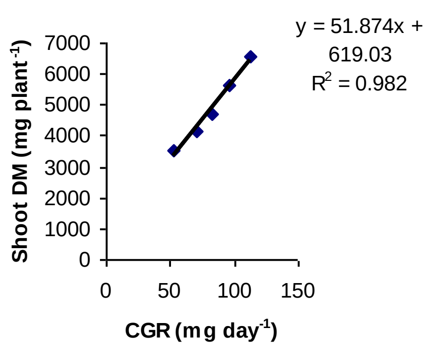

Fig. 4: Correlation between CGR and dry matter of shoot

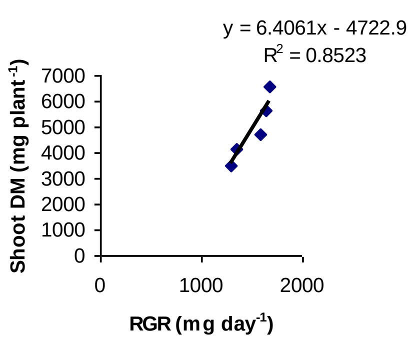

Fig. 5: Correlation between RGR and dry matter of shoot

CONCLUSION

In the beginning, CGR and RGR increased with a slower rate with L-TRP from 0.0025 to 0.25 mg kg^{-1} of soil, however the values increased rapidly from 0.25 to 2.5 mg kg^{-1}. At final harvest, L-TRP @ 2.5 mg kg^{-1} of soil caused

86.93 % increase in shoot dry matter over control. The associations of shoot dry matter with leaf area per plant, CGR and RGR were significant and positive. Positive and linear regression was established between L-TRP and shoot dry matter. Soil drenching @ 2.5 mg kg^{-1} of L-TRP produced significantly reflective effects on cell expansion, leaf area and shoot dry matter in maize.

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