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Improving Crop Yields by the Application of an Auxin Precursor L-tryptophan

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Abstract: Different field and pot trials were conducted to evaluate the effect of an auxin precursor, L-tryptophan on the growth and yield of rice, wheat, soybean, potato and tomato. Rice (cv. Basmati-385) seedlings treated with 10^{-2}-10^{-5} M and 10^{-1}-10^{-5} M L-TRP by dipping seedling roots in respective solutions for one hour gave maximum paddy yield and number of panicles per hill at 10^{-5} M, 10^{-2} M and 10^{-1} M L-TRP levels in different field trials. L-Tryptophan (10^{-4} M) significantly enhanced grain yield and 1000-grain weight of wheat (cv. Inqlab) in a field trial. Total biomass and grain yield in case of soybean (cv. William) were found maximum with 10^{-2} M L-TRP, fresh weight of tubers and yield of potato (cv. CEB 819-17) were observed at the highest value with 10^{-5} M L-TRP and number of fruits per plant and yield of tomato (cv. 366-87 Pakit) were at peak when treated at 10^{-4} M L-TRP in pot trials. In nutshell, L-tryptophan application to different crops significantly increased all the yield components. The data collected from different crops was subjected to Dunnett's test.

Key words: Auxins, L-tryptophan, Phytohormones

Introduction

The use of plant growth regulators (PGRs) in the field of agriculture has become commercialized in some advanced countries like Europe, USA and Japan. Microorganisms are known to produce PGRs upon utilization of some of the substrates which may influence plant growth and development (Lynch, 1985).

The presence of these plant growth regulators (PGRs) in soil is of much ecological importance. The availability of suitable precursors is one of the primary factors affecting microbial secretions of these secondary metabolites. The exogenous application of precursors results in increasing PGR production in cultures and soil by several fold (Arshad and Frankenberger, 1991). There are five major classes of PGRs including auxins, gibberellins, cytokinins, abscisic acid and ethylene. Auxins play key role in cell enlargement, cell division, vascular tissue differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting and flowering (Davies, 1987). The major auxin in plant is indole acetic acid (IAA) (Kaufman *et al*., 1989).

L-Tryptophan (L-TRP) is considered an efficient precursor of auxins in plants and microorganisms. Auxin production in soil is most likely to be active in the rhizosphere (Martens and Frankenberger, 1993). There are numerous microbiota actively involved in the synthesis of auxins in pure culture and soil (Arshad and Frankenberger, 1993). Application of L-TRP to soil may improve the growth and yield of plants most likely via its conversion into auxins by soil indigenous microbiota (Arshad and Frankenberger, 1993). Similarly in some other studies soil application of L-TRP has been shown to have a concentration dependent effect on growth and yield of maize, pepper, watermelon and muskmelon (Sarwar and Frankenberger, 1994, Frankenberger and Arshad 1991 a,b). Different field and pot trials were conducted to investigate the effect of exogenously applied auxin precursor, L-TRP on the growth and yield of rice, wheat, soybean, potato and tomato.

Materials and Methods

Different field and pot trials were conducted to evaluate the effect of L-tryptophan (L-TRP) application on the growth and yield of various crops. The crops subjected to field trials include rice (two trials) and wheat while soybean, potato and tomato were subjected to pot trials. In case of rice and tomato, seedling roots were dipped in respective L-TRP solutions for one hour before transplanting while crop seeds in all other trials were treated by dipping them in L-TRP solution for the same period of time before sowing. In control, seedlings/seeds were treated with simple tap water for the same period of time.

Field Trials: Rice (cv. Basmati-385) seedlings washed with tap water were subjected to treatment with different levels of L-TRP i.e. 10^{-2}-10^{-6} M and 10^{-1}-10^{-5} M in two field trials, respectively. Fertilizers; NPK as urea, single super phosphate, potassium sulfate at 114-62-62 kg ha^{-1} while $ZnSO_4$ at 12.5 kg/ha were applied with recommended procedures. At the time of maturity, paddy yield and number of panicles per hill were calculated.

In case of wheat (cv. Inglab) seed was treated with two levels of L-TRP (10^{-3}-10^{-4} M) and fertilizers; urea, diammonium phosphate and potassium sulfate were applied at 125-100-65 kg ha^{-1} with recommended procedures. After harvesting, thousand-grain weight and grain yield were recorded.

Pot Trials: Soybean (cv. william) , potato (cv. CEB 819-17) and tomato (cv. 366-87 Pakit) were treated with different levels of L-TRP in pot trials. In case of soybean, various treatments of L-TRP at 10^{-1}-10^{-6} M, for potato 10^{-4}-10^{-7} M and for tomato 10^{-4}-10^{-6} M were applied. At harvest, total biomass and grain yield of soybean, plant height and fresh weight of tubers in case of potato and, yield and number of fruits of tomato were recorded.

Table 1: Effect of L-TRP on rice and wheat (Field trials)

(Average of four repeats)

Treatments	Rice		Wheat
	No. of panicles per hill		
	Trial 1	Trial-2	1000-Grain weight (g)
Control	13.0	11.18	34.9
10^{-6} ML-TRP	14.9*	-	-
10^{-5} ML-TRP	16.7*	11.85	-
10^{-4} ML-TRP	14.6*	12.51*	36.6*
10^{-3} ML-TRP	14.5*	12.92*	36.2
10^{-2} ML-TRP	13.3*	16.44*	-
10^{-1} ML-TRP	-	16.52*	-

* Means significantly different from control at p =0.05 according to Dunnett's test.

Table 2: Effect of L-TRP on soybean, potato and tomato (Pot trials)

(Average of five repeats)

Treatments	Soybean	Potato	Tomato
	Total biomass (g/plant)	Plant height (cm)	No. of fruits per plant
Control	14.67	43.4	2.6
10^{-7} L-TRP	-	46.4*	-
10^{-8} L-TRP	14.2	45.4	6.3*
10^{-5} L-TRP	15.49	46.8*	5.6*
10^{-4} L-TRP	17.44*	45.3	7.0*
10^{-3} L-TRP	19.12*	-	-
10^{-2} L-TRP	21.69*	-	-
10^{-1} L-TRP	20.94*	-	-

* Means significantly different from control at p = 0.05 according to Dunnett's test.

The data were subjected to analysis of variance (ANOVA) and comparison of means with control was made by Dunnett's test (Steel and Torrie, 1980).

Results and Discussion

Results revealed that different growth and yield parameters of various crops were significantly increased in response to application of varying levels of L-TRP.

Field Trials: Maximum paddy yield (Fig. 1) and number of panicles per hill (Table 1) of rice seedlings treated with L-TRP at 10^{-2}-10^{-6} M were found with the 10^{-6} M L-TRP level and they were 42.9 percent and 28.5 percent more as compared to untreated control. Whereas rice seedlings treated with 10^{-1}- 10^{-5} M L-TRP showed maximum paddy yield (Fig. 1) and number of panicles per hill (Table 1) at 10^{-2} M and 10^{-1} M L-TRP levels and they were 43.5 percent and 47.9 percent higher than control, respectively.

Two levels of L-TRP (10^{-3} and 10^{-4} M) applied to wheat showed significant increase. Maximum grain yield (Fig. 1) and 1000-grain weight (Table 1) were observed at lower level of L-TRP (10^{-4} M) and they were 11.7 and 4.7 percent higher than control, respectively.

Pot Trials: Soil application of L-TRP significantly influenced the growth and yield of soybean . In case of total biomass (Table 2), higher concentrations of L-TRP i.e. from 10^{-1}-10^{-4} M gave significantly better results and it was increased by about 50 percent compared with control in response to 10^{-2} M L-TRP. Grain yield per plant (Fig. 2) was significantly increased by L-TRP ranging from 10^{-1}-10^{-3} M. The highest levels of L-TRP (10^{-1}-10^{-2} M) caused an increase of 59.0 percent in grain yield compared with control.

Various levels of L-TRP application to potato significantly increased plant height and fresh weight of tubers. Maximum plant height (Table 2) and fresh weight of tubers (Fig. 2) were observed at 10^{-5} M L-TRP and they were 7.83 percent and 16.68 percent higher than control.

Three different levels of L-TRP 10^{-4}-10^{-5} M) applied to tomato gave tremendous results. L-tryptophan at 10^{-4} M gave maximum increase in yield (Fig. 2) and number of fruits per plant (Table 2) which were 81.8 percent and 169.2 percent higher as compared to control.

The data presented here reveal that addition of auxin precursor, L-TRP to soil and root seedlings can significantly alter growth and development of different crops. The effect of this precursor may be through their conversion into its auxins by the activity of indigenous rhizosphere microbiota followed by uptake by plant roots. However other possibilities such as direct uptake of these precursors by plant roots and subsequent conversion into respective

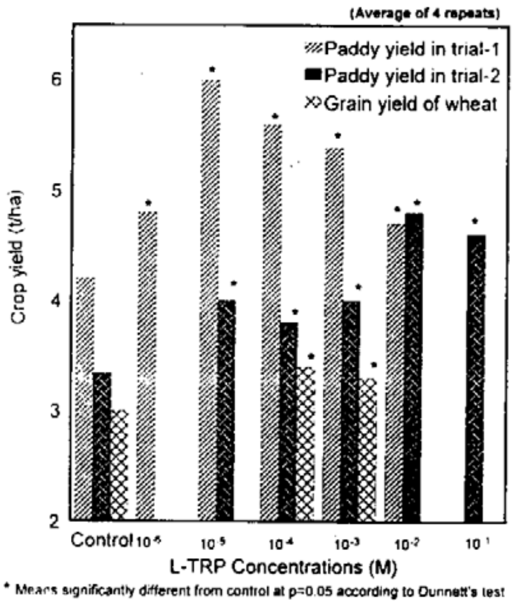

Fig 1: Effect of L-TRP on rice and wheat yields in field trials

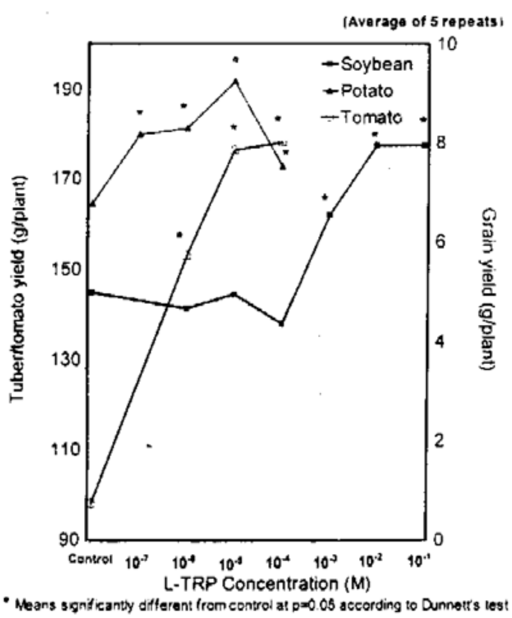

Fig. 2: Effect of L-TRP on yields of potato, tomato and soybean crops in pot trials.

phytohormones within the plant tissues and/or change in the balance of rhizosphere microflora affecting plant growth cannot be excluded. Our results are in agreement with previous studies in which L-TRP application affected the growth and yield of radish, melon, cantaloupe, pepper, maize, wheat, soybean and cotton (Frankenberger *et al.*, 1990; Frankenberger and Arshad, 1991 a,b; Sarwar and Frankenberger, 1994; Martens and Frankenberger 1992: Arshad *et al.,* 1994, 1995).

References

Arshad, M. and W.T. Frankenberger Jr., 1991. Microbial production of plant hormones. Plant Soil, 133: 1-8.

Arshad, M. and W.P. Frankenberger Jr., 1993. Microbial Production of Plant Growth Regulators. In: Soil Microbial Ecology: Application in Agricultural and Environmental Management, Metting, Jr. F.B. (Ed.). Marcel Dekker Inc., New York, USA., ISBN-13: 9780824787370, pp: 307-347.

Arshad, M., M. Javed and A. Hussain, 1994. Response of soybean (*Glycine max*) to soil applied precursors of phytohormones. PGRSA Quart., 22: 109-115.

Arshad, M., A. Hussain and A. Shakoor, 1995. Effect of soil applied L-tryptophan on growth and chemical composition of cotton. J. Plant Nutr., 18: 317-329.

Davies, J.P., 1987. Plant Hormones and their Role in Plant Growth and Development. Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

Frankenberger, Jr. W.T., A.C. Chang and M. Arshad, 1990. Response of *Raphanus sativus* to the auxin precursor, L-tryptophan applied to soil. Plant Soil, 129: 235-241.

Frankenberger, Jr. W.T. and M. Arshad, 1991a. Yield response of *Capsicum annuum* to the auxin precursor, L-tryptophan applied to soil. PGRSA Quart., 19: 231-240.

Frankenberger, Jr. W.T. and M. Arshad, 1991b. Yield response of watermelon and muskmelon to L-tryptophan applied to soil. HortScience, 26: 35-37.

Kaufman, P.B., T.F. Carlson, P. Dayanandan, M.L. Evaus, J.B. Fisher, C. Parks and J.R. Wells, 1989. Plants: Their Biology and Importance. Harper and Row Publishers, New York, USA., ISBN-13: 9780060435752, Pages: 757.

Lynch, J.M., 1985. Origin, Nature and Biological Activity of Aliphatic Substances and Growth Hormones Found in Soil. In: Soil Organic Matter and Biological Activity, Vaughan, D. and R.E. Malcolm (Eds.). Chapter 4, Martinus Nijhoff/Dr. W. Junk Publ., Netherlands, ISBN: 978-94-009-5105-1, pp: 151-174.

Martens, D.A. and W.T. Frankenberger Jr., 1992. Assimilation of 3-C-indole acetic acid and tryptophan by wheat from nutrient media. Proceedings of the 19th Annual Meeting of the Plant Growth Regulator Society of America, July 17-20, 1992, San Francisco, CA., USA., pp: 99-100.

Martens, D.A. and W.T. Frankenberger Jr., 1993. Metabolism of tryptophan in soil. Soil Biol. Biochem., 25: 1679-1687.

Sarwar, M. and W.T. Frankenberger Jr., 1994. Influence of L-tryptophan and auxins applied to the rhizosphere on the vegetative growth of *Zea mays* L. Plant Soil, 160: 97-104.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics: A Biometrical Approach. 2nd Edn., McGraw Hill Book Co., New York, USA., ISBN-13: 9780070609266, Pages: 633.