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Effect of an Auxin Precursor L-tryptophan on Growth and Yield of Rice (*Oryza stiva* L.)

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Abstract
Being a physiological precursor of auxins, L-tryptophan (L-TRP) can have an ecological impact on the growth and development of some plants. A field experiment was conducted to assess the influence of L-TRP on growth and yield of rice. Results showed that specific growth and yield parameters were significantly promoted in response to various L-TRP treatments. L-tryptophan application at 10^{-5} M significantly increased the plant height (4.25%), paddy yield (41.5%), number of tillers (29.4%) and number of panicles (27.9%) compared to control. Results of this study demonstrated that the growth and yield of rice may be enhanced with the application of an auxin precursor, L-TRP. Bioproduction of plant growth regulators such as auxins in soil as a result of microbial activity from the added precursor may be recognised as having a potential influence on plant growth and development. Further studies are needed to investigate factors affecting the microbial production of auxins such as their distribution and stability in soil and their direct uptake by plants.

Key words: Auxins, Physiological precursor, L-tryptophan, Rice

Introduction
Auxins, a major class of plant hormones, have shown to be involved in a variety of plant growth and development responses. They are synthesized indigenously by plants, however, several studies demonstrated that plants can respond to exogenously applied auxins (Zelena *et al.*, 1988; Park *et al.*, 1992). This response may be due to the lack of sufficient endogenous auxins for optimal growth and development under sub-optimal climatic and environmental conditions. An exogenous application of auxins may affect the endogenous hormonal pattern of the plant, either by supplementation of sub-optimal levels or by interaction with the synthesis, translocation or inactivation of existing hormone levels (Arshad and Frankenberger, 1993).
In addition to higher plants, soil microbiota are also active produers of auxins particularly in the presence of L-TRP (Arshad and Frankenberger, 1993; Frankenberger and Arshad, 1995). Exogenous application of L-TRP to soils has been shown to result in elevated levels of auxins (Sarwar *et al.*, 1992; Martens and Frankenberger, 1993). Auxin production in soil is most active in the rhizosphere or at microsites where substrates and microorganisms are abundant (Rossi *et al.*, 1984). Thus, substrate-derived auxins in the direct vicinity of plant roots may have a physiological role in the growth and development of plants. Present study was conducted to investigate the effect of exogenously applied auxin precursor, L-TRP on growth and yield of rice.

Materials and Methods
A field experiment was conducted at Postgraduate Agricultural Research Station (PARS), University of Agriculture, Faisalabad to evaluate the effect of L-TRP application on growth and yield of a rice cv. "Basmati 385''. Fertilizers, NPK, as urea, single super phosphate and potassium sulfate were applied at 114-62-62 kg ha^{-1}, respectively, with whole of P, K and half of N at the time of transplanting while the remaining half at panicle intitiation i.e. 35-40 days after transplanting. In addition to NPK, Zinc sulfate at 12.5 kg ha^{-1} was applied after 7-10 days of transplanting. Rice seedlings were transplanted by maintaining plant to plant and row to row distance of 23 cm in a sandy clay loam field having pHs, 7.31; ECe, 1.71 dS m^{-1}; total nitrogen, 0.05 percent available phosphorus, 7.1 mg kg^{-1} soil and extractable K, 116 mg kg^{-1} soil.
Seedling roots were washed with tap water and dipped in five levels of L-TRP (10^{-6} to 10^{-2} M) for one hour. In case of control, the seedlings were dipped in simple tap water for the same period of time. The treatments were replicated four times in randomized complete block design and canal water was used for irrigation. One square meter (1 m^2) area was harvested randomly from each treatment and different growth and yield parameters were recorded at maturity. The data obtained were subjected to Dunnett T-test (Steel and Torrie, 1980).

Results
Results revealed that different growth and yield parameters of rice were significantly increased in response to application of various levels of L-TRP. Plant height was significantly increased by some levels of L-TRP (Table 1, Fig. 1). Maximum plant height was observed where 10^{-5} M L-TRP was applied and it was 4.25 percent higher over control. Minimum increase in Plant height (0.14% higher than control) was observed in response to 10^{-2} M L-TRP application.
Maximum paddy yield was observed where 10^{-5} M L-TRP was applied and it was 41.5% higher than control. Minimum increase in paddy yield (11.76% higher than control) was observed in response to 10^{-2} M L-TRP application.
Data given (Table 1) showed that decreasing L-TRP concentrations resulted in increased number of tillers hill^{-1}. Highest number of tillers hill^{-1} were recorded with 10^{-5} M

Table 1: Effect L-trypotphan on plant height, number of tillers per hill, number of panicles per hill and 1000-grain weight

L-TRP conc. (Molar)	Plant Height (cm)	No. of tillers hill^{-1}	No. of panicles hill^{-1}	1000-grain wt. (g)
Control	93.10c	14.56e	13.05d	19.52NS
10^{-6}	94.29b	17.43b	14.87b	19.62
10^{-5}	97.06a	18.84a	16.69a	20.81
10^{-4}	94.29b	17.37b	14.56b	20.30
10^{-3}	94.54bc	16.56c	14.50b	20.20
10^{-2}	94.23c	15.06de	13.31cd	19.60

NS = Non significant
Means sharing similar letter(s) do not differ significantly at $p<0.05$.

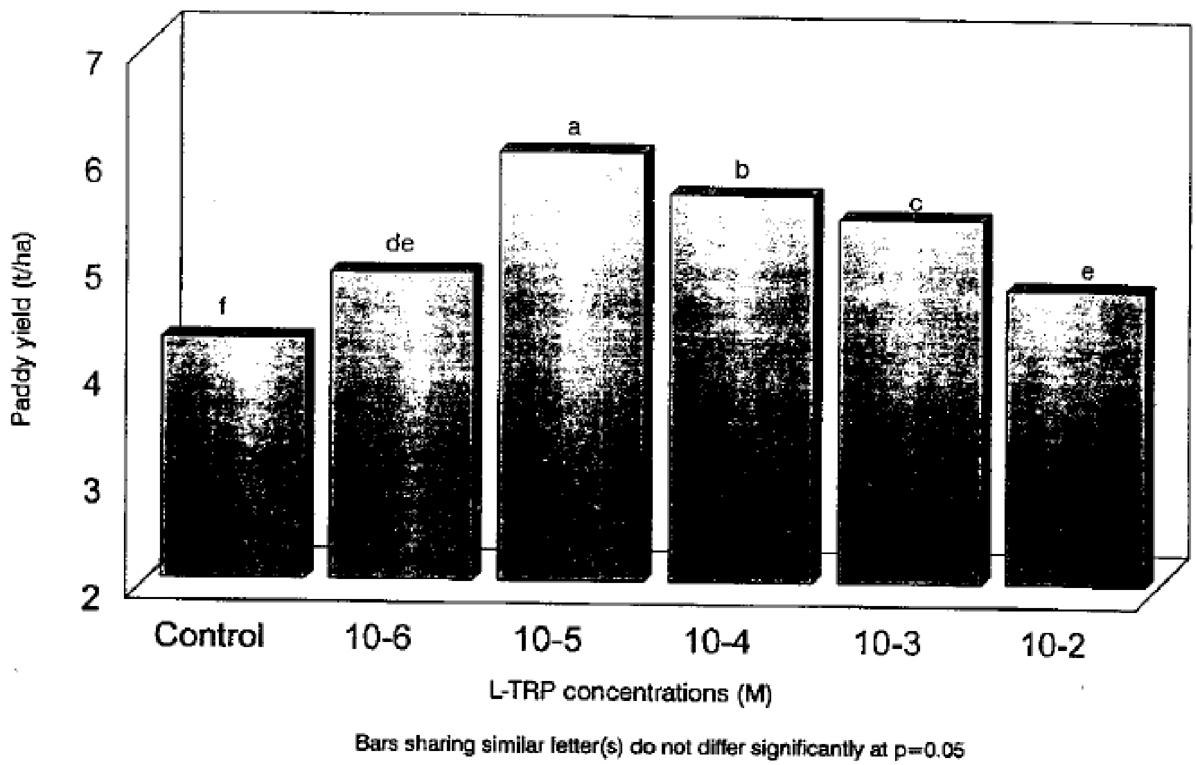

Fig. 1: Effect of L-tryptophan on paddy yield of rice

of L-TRP application which was 29.4% higher than control. It differed significantly from control and other treatments. Minimum increase in number of tillers hill^{-1} (3.43% higher than control) was found where 10^{-2} M L-TRP was applied. Similarly, application of L-TRP at 10^{-5}) M was also more effective in increasing the number of panicle hearing tillers hill (Table 1). Maximum number of panicle bearing tillers hill was counted with L-TRP (10^{-5} M) which was 27.9% higher than control and differed significantly from untreated control and other treatments. Application of L-TRP at10^{-2} M was found to be the least effective in increasing number of panicle bearing tillers hill^{-1} (2.0% higher than control). Data regarding 1000-grain weight revealed that L-TRP application had no significant effect on this parameter.

Discussion

L.-tryptophan is a well established precursor of auxins in higher plants and for microbially-derived auxins in pure culture and soil (Frankenberger and Arshad, 1995). The effect of L-TRP on growth and yield of rice could be attributed to either auxin metabolites produced by the rhizosphere microflora which were subsequently taken up by plant roots or direct uptake of L-TRP by the plant roots with subsequent catabolism into auxins within the plant tissue and/or alteration in the balance of the rhizosphere microbial community in response to L-TRP addition which may affect growth and yield of rice. However, Martens and Frankenbergar (1994) reported very poor uptake of labeled L-TRP compared with labeled IAA by wheat seedling roots. They also demonstrated poor endogenous conversion of exogenously applied labeled tryptophan into auxins by wheat seedlings grown under axenic environments. Addition of labeled 3-14C-IAA to aseptic sterile and non sterile soil resulted in assimilation and translocation of the label to the shoot tissues as amino acid conjugates of IAA (Martens and Frankenberger, 1992). This implies that auxins produced by the rhizosphere microflora derived from L-TRP could be taken up by the plant roots and may be translocated to the shoots resulting in a physiological response. So the physiological response could most likely be evoked by the auxins derived from microbial catabolism of L-TRP in the vicinity of rhizospere.

Previous studies have shown that application of L-TRP had a significant positive effect on the growth and yield of wheat, corn, soybean and cotton (Martens *et al*., 1992; Sarwar and Frankenberger, 1994; Arshad *et al*., 1994, 1995) when applied to soil or sand. Frankenberger *et al*. (1990) compared the effect of L-TRP with known auxins Undole-3-acetic acid, Indole-3-acetamide and indole-3-lactic acid) on growth and yield of radish and found that L-TRP was either equally effective or better than these pure auxins in terms of yield.

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