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RESEARCH

COMPARATIVE ALLELOPATHIC INTERACTIONS OF *S.TORVUM* (SW.) AND *T. PORTULACASTRUM* (L.) WITH *V. UNGUICULATA* (L.) WALP.VAR. PK

Prabhat Singh*

Department of Botany, Sanjay Gandhi (P.G.) College Sarurpur Khurd, Meerut, UP
Email: pskohli007@gmail.com

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Abstract: Studies were carried out to determineallelopathic interactions of a perennial weed *Solanumtorvum* (Sw.) (Solanaceae) and a seasonal weed *Trianthema portulacastrum* (L.) (Aizoaceae) with a leguminous crop *Vigna unguiculata* (L.)Walp.var. Pusa Komal (Lobia) at seedling stage. When Lobia seeds were grown in different concentration of *S. torvum* leaf leachates, the morphological attributes like % germination, shoot length, root length, biomass, vigour index, tolerance index, germination speed and biochemical parameters viz. chlorophyll content, protein, α-amylase and peroxidase activity increased maximallyat 2% concentration of*S. torvum* leaf leachate (SLL) as compared to control (DDW). On the other hand, in seedlings grown in different concentrations of *T. portulacastrum* leaf leachates (TLL), most of morphological and biochemical parameters increased maximally at 1% concentration. There was negligible germination in 10% *T. portulacastrum* leaf leachate showing highest phytotoxicity at this concentration. The studies indicate that*V. unguiculata* var. PK underwent stimulation/toleranceupto 2% SLL, while seedlings exhibit stimulation at 1% TLL and further higher concentrations of SLL/TLL are phytotoxic to *V. unguiculata* var. PK as compared to control. Studies also indicate that *T. portulacastrum* leaf leachate exhibits more phytotoxicity on *Vignaunguiculata* var. PK as compared to *S. torvum* leaf leachate.

Keywords: *Solanum torvum*,Tolerance index, *Trianthema portulacastrum*, Vigour index

INTRODUCTION

Allelopathy concerns with any direct or indirect, beneficial or harmful effect of one plant on another through the release of allelochemicals into the surroundings.Allelochemicalsmay be present in all type of plants and their parts such as roots, stem, leaves, inflorescence and even pollen grains and are released into the soil rhizosphere by a variety of mechanisms, including leaching, decomposition of residues, volatilization and root exudation (Rice, 1984). Leaves may be the most consistent producers of allelochemicals as compare to other parts (Putnam, 1985). Many investigators reported that allelochemicals may have stimulatory or inhibitory effects on seed germination and seedling growth of other plants (Gupta *et al.*, 1992; Jeyasrinivas *et al.*, 2006).
Allelopathy is considered as a novel approach to keep the environment safe and to maintain sustainability in agriculture (Yongqing, 2005).The weeds may have either positive or negative effects on the growth of nearby plants. Allelopathic effects of weeds on germination and seedling growth of crops vary from weed to weed (Hamayun *et al.*, 2005).
*S. torvum*and *T. portulacastrum* are the serious weeds of the world (Holm *et al.*,1977; Balyan and Bhan, 1986). Information about the allelopathic effects of leaf leachates of these weeds on the germination and seedling growth of *V. unguiculata* var. PK, is scarcely available. Therefore, the allelopathic effects of leaf leachates of these weeds on the germination and early growth of *V. unguiculata* var. PK were investigated in the laboratory.
Present work was focused on the effects of weeds on crop to determine the allelopathic potential of the leaf leachates of *S. torvum*and *T. portulacastrum* that can inhibit or induce the germination and seedling growth of *V. unguiculata* var. PK and to determine, whetheror not, there is a significant difference in the allelopathic potentials of leaf leachates of these two weeds on the germination seedling growth of *V. unguiculata* var. PK.

MATERIALS AND METHODS

Solanumtorvum Sm. (Turkey berry) is an evergreen, widely branched, prickly perennial shrub (weed) or small tree of family solanaceae and is distributed in tropical and subtropical areas throughout the world (Wagner *et al.*, 1999) while *Trianthemapor-tulacastrum* L. (Horse-purslane) is a much branched, prostrate and annual terrestrial weed of the family Aizoaceae which is an indigenous plant to South Africa and has been distributed widely in India, Srilanka,West Asia, Africa and Tropical America (Duthie, 1960, Balyan and Bhan, 1986).

*Corresponding Author

Vignaunguiculata (L.)Walp.var. PusaKomal (Cow pea; hindi name-Lobia) is a forage crop which belongs to family Leguminoceae and subfamily papilionaceae. It is an annual sub-erect plant with the stem growing as thin succulent long twiners (Aiyer, 1980).

The experiments were conducted at Department of Botany C.C.S. University Campus, Meerut (Latitude 29^0 01`N; Longitude $77^0$ 43` E; 730 feet asl) in Uttar Pradesh. For the present study, the leaf leachates were prepared by soaking 100 g of air dried senescent leaves*S. torvum*and *T. portulacastrum* each of in 1 liter of double distilled water separately for 24 hours at room temperature. The solution was filtered with Whatman filter paper No.40 and made up to 1 liter with double distilled water (i.e. 10% concentration) which was further diluted to 1, 2, 5, and 10% with double distilled water.

Healthy seeds of *V. unguiculata* var. PK were disinfected with 0.1% $HgCl_2$ solution for 5 minutes and washed 5-6 times with distilled water to remove its traces. 50 healthy seeds (10 in each replicate) were allowed to germinate under each treatment (1, 2, 5 and 10% of *S. torvum*and *T. portulacastrum* leaf leachates) in thermocol bowls filled with washed and oven dried sand and saturated on alternate days with 1, 2, 5 and 10% leachates at room temperature inside the laboratory. Distilled water treatment was considered as control.

Morpho-physiological observations were recorded on 10^{th} day after radical emergence. Germination %, root and shoot length, fresh weight, dry weight per seedling and moisture % were measured as suggested by Anonymous (1985).Vigour Index was calculated according to the method as adopted by Abdul Baki and Anderson (1973).

- $$\text{Vigour Index (V.I.)} = \text{Root length} + \text{Shoot length of seedling} \times \text{\% germination}$$

  The tolerance index was calculated according to the formula given by Turnur and Marshal (1972).

- $$\text{Tolerance Index} = \frac{\text{Mean length of longest root in test solution}}{\text{Mean length of longest root in control}} \times 100$$

  Germination speed was calculated according to ISTA (1976).

- $$\text{Germination Speed} = \frac{\text{\% Germination}}{\text{Day of completion of germination}} \times 100$$

Chlorophyll content (Arnon, 1949), protein (Lowry *et al.*, 1951), α-amylase (Filner and Varner, 1967), protease (Green and Neurath, 1954) and peroxidase activity and total Nitrogen (Snell and Snell, 1949), Phosphorous, Carbohydrates (Nelson, 1944) and Phenolics (Bray and Thorpe, 1954), are used as biochemical attributes for plants analysis, while pH, Cation Exchange Capacity (Jones, 1967), Organic Carbon (Datta *et al.*, 1962), Total Nitrogen (Snell and Snell 1949) and Phosphorous are used for analysis of soil.

RESULTS AND DISCUSSION

After 10 days of seedling growth of *V. unguiculata* var. PK,% germination, root length, shoot length, biomass, vigour index (VI), tolerance index (TI) and germination speed increased upto 2% concentration of *S.torvum* leaf leachates (SLL) as compared to control (DDW). These morpho-physiological parameters decreased on further increase in concentration (*i.e.* 5-10%) of SLL. This indicates that 2% SLL shows stimulatory effect on germination and seedling growth of *V. unguiculata* var. PK, while higher concentrations (*i.e.* 5-10%) of SLL exhibit inhibitory effect. On the other hand, in seedlings grown in different concentrations of *T. portulacastrum* leaf leachates (TLL), % germination, shoot length, fresh weight, vigour index (VI) and germination speed increased at 1% concentration while root length, dry weight and tolerance index (TI) were increased up to 2% TLL, this increase may be due to greatly decline in protease activity in root as compare to shoot.

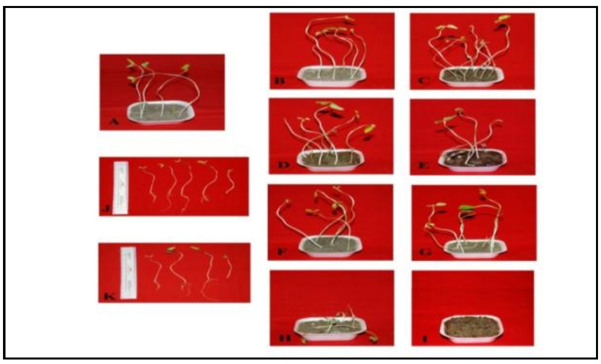


Figure -1: Growth of *V. unguiculata*var. PK seedlings (10 DAR) in **A.** DDW (control), **B.** 1% SLL (*S. torvum* leaf leachate), **C.** 2% SLL, **D.** 5% SLL, **E.** 10% SLL, **F.** 1% TLL (*T. portulacastrum* leaf leachate), **G.** 2% TLL, **H.** 5% TLL, **I.** No germination in 10% TLL. **J.** Comparative growth of *V. unguiculata*var. PK, Control Vs 1%, 2%, 5% & 10% SLL and **K.** Comparative growth of *V. unguiculata*var. PK, Control Vs 1%, 2%, 5% & 10% TLL.

The decline in protease activity may be responsible for increased protein content in root which may results the increase of root length and dry weight (Figure-2).Increased α-amylase activity at 5% SLL and 1% TLL along with Chl.a, chl.b total chlorophyll, as compared to control, matching with increased RS, NRS and TS may be responsible for synthesis of sugars along with their mobilization to sink parts and its vice-versa at higher concentration. Reduction in chlorophyll content observed at higher concentrations of SLL and TLL may be due to the degradation of chlorophyll pigments or reduction in their synthesis by the action of allelochemicals present in leaf leachates, as suggested by Tripathy *et al. (*1999). Decline in protease activity up to 2% concentration of both SLL and TLL, as compared to control indicates protein accumulation at this concentration. Further increase in concentration of SLL and TLL leads to gradual increase in protease activity which may correlates with decrease in protein content, α-amylase and peroxidase activity at higher concentration (Figure-3). The parameters including P, RS, NRS and TS in seedlings of *V. unguiculata* var. PK were observed to be increase up to 5% concentration of SLL, as compared to control. Nitrogenand phenolics were increased up to 2% and 10% concentration of SLL, respectively. Although, RS, NRS and TS were increased upto 5% SLL along with increased chlorophyll contents but the seedling growth was stimulated upto 2% SLL where RS, NRS and TS increased maximally, it may be due to conversion of sugars to defense metabolites as indicated by increased phenolic content of seedlings at this concentration. In seedlings of *V. unguiculata* var. PK treated with TLL all the above parameters except RS and phenolics were observed to be increase upto 2% concentration as compared to control and on further increase in concentration, they decreased. RS and phenolic content rose with increase in concentration upto 5% of TLL. Increased sugar content along with N and P may be responsible for the biosynthesis of defense metabolites resulting increased tolerance at 2% TLL(Figure-4).

Impact on soil fertility

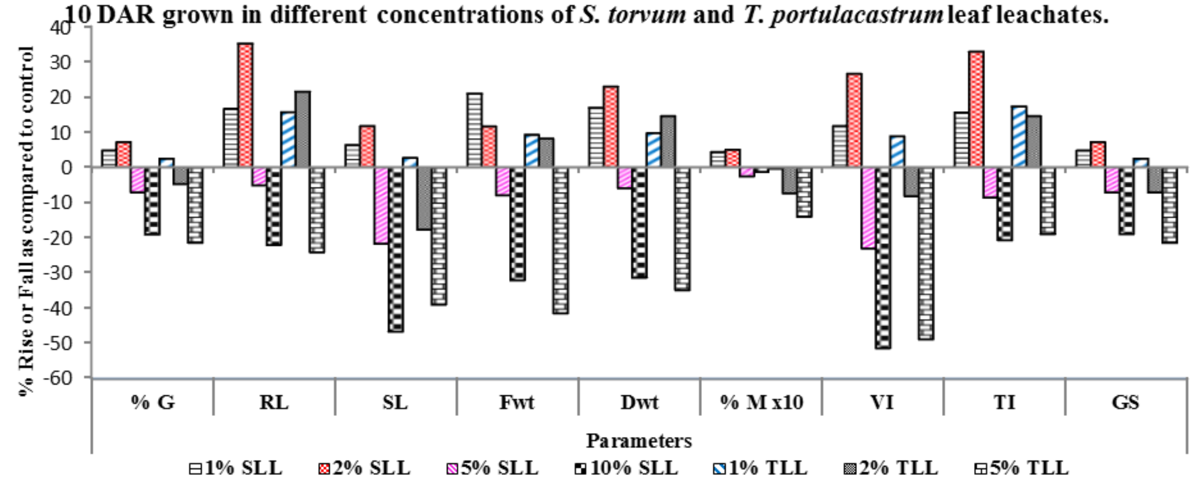
In sand treated with SLL and TLL pH, % OC, N and P increased at all concentration of both leaf leachates over initial sand. Decline of N in seedlings matched with increase of N in the medium (sand treated with SLL or TLL) indicating leaching of N from plants to medium. % moisture and CEC in SLL and TLL increased up to 2% and at 1% TLL, as compared to control as well as initial. On further increased in concentration of both SLL and TLL, % moisture and CEC decreased. Decline in CEC may be due to increased phenolics activity of both SLL and TLL, which may cause the decline in availability essential nutrient elements required for seedling growth and may responsible for growth reduction at higher concentration of both SLL and TLL (Figure-5). The results are in conformity with Batlang and Shushu (2007) who reported that allelochemicals inhibit germination and seedling growth probably by affecting the processes of cell division and elongation or by interfering with enzymes involved in the mobilization of nutrients required for germination.

These findings indicate that SLL (up to 2%) and TLL(at 1%) are stimulatory for the growth of *V. unguiculata*var. PK and inhibitory at higher concentrations. Higher concentration of leachates probably interferes with nutrient absorption and hence, becomes inhibitory for the studied crop plants. TLL exhibits more phytotoxicity against *Vignaunguiculata* var. PK as compared to SLL. Similar results were reported by Ali *et al. (*2013) who reported that the soil-incorporated residues (1-4% w/v) of *Rhyncosiacapitata* stimulated the growth of root and hypocotyl of mungbean at low concentrations, while it inhibited their growth at higher concentrations. Negligible germination in 10% TLL showing highest phytotoxicity and it may be due to comparatively lowest value of CEC and highest pH, at this concentration or highlyinhibitory effect of allelochemicals (present in TLL) to seed germination, could be attributed to inhibit water absorption which is a precursor of physiological processes that should occur in seeds before germination is triggered (Dadkhah and Assadi, 2010).

CONCLUSIONS

V. unguiculata var. PusaKomal underwent stimulation up to 2% SLL, while seedlings exhibit stimulation at 1% TLL and higher concentration of TLL is more phytotoxic to *V. unguiculata* var. PusaKomal as compared to SLL. Leaf leachates of both *S. torvum*and *T. portulacastrum* are reported to exhibit stimulatory effect on % germination and seedling growth of important forage crop *V. unguiculata* var. PK when applied in lower concentration followed by an inhibition when applied in higher concentrations. Higher concentration of leachate probably interferes with nutrient absorption and hence, becomes inhibitory for the studied crop plants. The results are in conformity with studies of Rice (1984), Lovett *et al.* (1989) and Liu and Chen (2011) who have already proved that allelochemicals can stimulate the seedlings growth at low concentrations but can inhibit the growth at high concentrations.

Figure-2: % Rise and fall in morpho-physiological attributes of *Vigna unguiculata* var. PK seedlings at 10 DAR grown in different concentrations of *S. torvum* and *T. portulacastrum* leaf leachates.



(G = germination, RL = root length, SL = shoot length, Fwt = fresh weight, Dwt = dry weight, M = moisture, VI = vigour index, TI = tolerance index and GS = germination speed)

Figure-3: % Rise and fall in biochemical attributes of 10 days old seedlings of *V. unguiculata* var. PK grown in different concentrations of *S. torvum* and *T. portulacastrum* leaf leachates

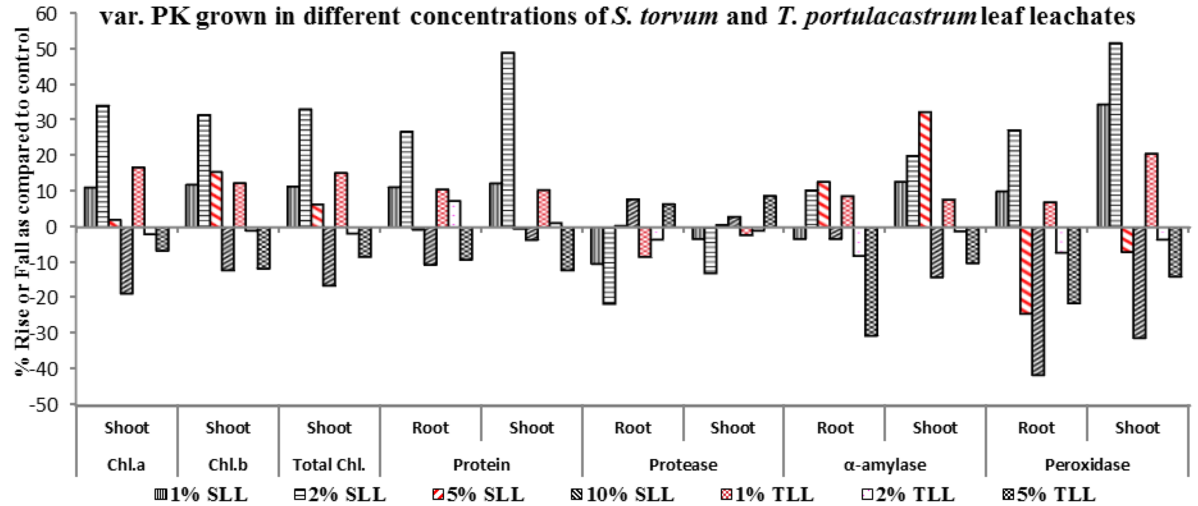
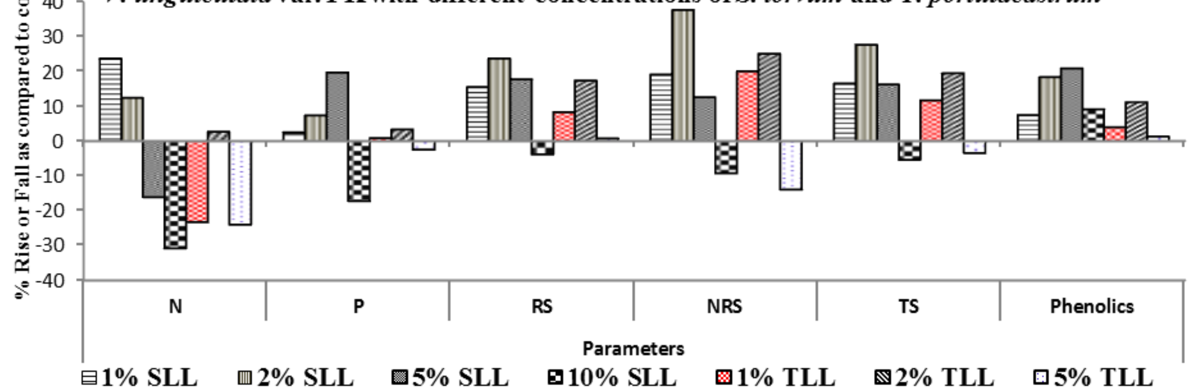


Figure-4: % Rise and fall in physico-chemical analyses of 10 days old oven-dried seedlings of *V. unguiculata* var. PK with different concentrations of *S. torvum* and *T. portulacastrum*



(N = total nitrogen, P = Phosphorus, RS = reducing sugar, NRS = non-reducing sugar and TS = total sugar)

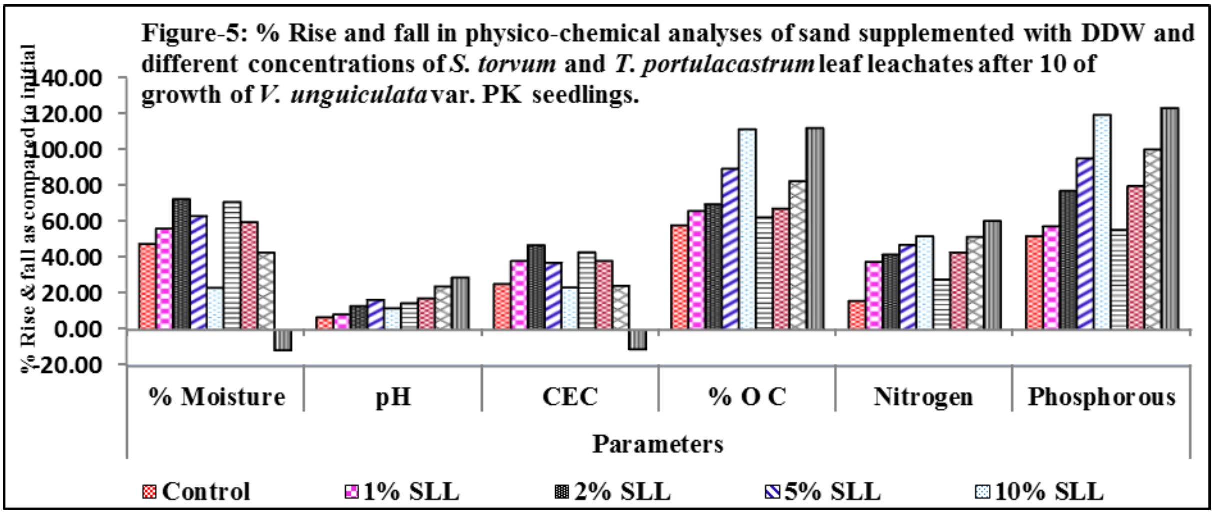


Figure-5: % Rise and fall in physico-chemical analyses of sand supplemented with DDW and different concentrations of *S. torvum* and *T. portulacastrum* leaf leachates after 10 of growth of *V. unguiculata* var. PK seedlings.

(CEC = cation exchange capacity and OC = organic carbon)

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