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Short Communication

EFFECT OF *DATURA METEL* ON CROP GROWTH AND PHYSIOLOGY OF BELL PEPPER

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ABSTRACT

Generally, crop residue is mixed in the soil to improve soil fertility that leads to enhanced crop growth and yield. However, in the present study, instead of the use of conventional crop residues, the effect of soil amendment with dry biomass of a weed *Datura metel* L. was studied on growth, yield and physiology of green bell pepper (*Capsicum annuum* L.). Different concentrations of dry biomass of *D. metel* (DBD) *viz*. 0.5, 1, 1.5, 2, 2.5 and 3% were mixed in the potting soil, left for one week after irrigation, and bell pepper seedlings were transplanted. In general, there was a gradual increase in different parameters of vegetative and reproductive growth of bell pepper due to an increase in the concentration of DBD up to 2% and a decline thereafter. A maximum increase of 44%, 45%, 14%, 38% and 83% in shoot length, shoot dry weight, root dry weight, and the number and dry weight of fruits, respectively, were observed due to application of DBD as compared to control. A 3% DBD application drastically reduced the plant growth and yield as compared to control or lower doses of DBD. Chlorophyll content was significantly increased by 1% DBD. Phenolic content was decreased by increasing DBD concentration and the effect of 2.5% amendment was significant ($P \leq 0.05$). Soil amendment had an insignificant effect on protein content and activities of peroxidase (POX) and phenylalanine ammonia lyase (PAL). Polyphenol oxidase (PPO) activity was significantly enhanced by 2.5 and 3% DBD. This study concludes that a 2% soil amendment with DBD can significantly improve growth and yield of bell pepper.

Keywords: Bell pepper; *Datura metel*; plant physiology; soil amendment.
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INTRODUCTION

Nutrients are depleted in the soil due to continuous cropping. In order to improve nutrient deficiency, use of synthetic inorganic fertilizers is in practice. However, due to ever-increasing cost as well as problems associated with the use of these inorganic fertilizers such as soil and surface water deterioration, farmers are continuously searching for alternatives (Antonious, 2016). Organic fertilizers are the best alternative to these synthetic fertilizers which have the advantage of providing essential nutrients such as NPK for a longer time period due to slow-release process (Cattanio *et al*., 2008). These organic amendments not only reduce the need of inorganic fertilizers but also improve the soil structure, nutrient composition and organic matter contents with enhanced soil microbiological activities (Bouajila and Sanaa, 2011). A number of organic amendments can be added to the soil including chicken manure, sewage sludge, cattle manure (Faria *et al*., 2020); crop residue (Lal, 2008) and green manure (Khan *et al*., 2020). Generally, residues of cereal crops such as wheat, rice and maize, and green manures of leguminous crops such as *Vicia villosa*, *Sesbania rostrata*, *Trifolium alexandrinum*, *T. incarnatum* etc. are used as soil amendments. However, there are a few reports of using biomass of some weeds such as *Parthenium hysterophorus* (Javaid and Shah, 2008; Javaid *et al*., 2009), *Synedrella nodiflora, Chromolaena odorata* and *Mikania micrantha* (Hamdani *et al*., 2017), *Tephrosia* sp. and *Achyranthus* sp. (Parbhankar and Mogle, 2017) as soil organic amendments with very encouraging results on crop growth and yield. There are further possibilities of using plant biomass of other agricultural and wasteland weeds as soil amendments for improvement of soil fertility and crop growth for which investigations are yet to be needed.

Datura metel is an annual weed plant of family Solanaceae. It is of American origin and widely naturalized in subtropical and tropical regions of the world. Now it is commonly found in Europe, South Africa, South America, Asia and Southeast Asian countries (Kerchner and Farkas, 2020). It grows well in gardens, along roadsides, and in cultivated fields and on wastelands. It is also cultivated as a potential source of bioactive secondary metabolites with antifungal, antibacterial, anti-microbial, nematicidal and insecticidal activities (Karim *et al*., 2017; Nandakumar *et al*., 2017). From prehistoric times, its different plant parts were practiced to cure specific ailments due to the presence of phytochemical substances like alkaloids, saponins, tannins, flavonoids, glycosides, phenols, withanolides, trigloylesters, pseudotropine, tropane, atropine,

scopolamine and calystegine (Alam *et al*., 2020). In herbal medicine system, it is used for psoriasis, skin inflammations, ulcer, jaundice, scabies, allergies, tumor, mumps, asthma, piles, diarrhea, diabetes and bronchitis (Kumar *et al*., 2017; Alam *et al*., 2020). The plant also has anodyne, narcotic, anti-tussive, anti-spasmodic, anodyne, mydriatic and hypnotic effects (Monira and Munan, 2012). However, there is not any previous report regarding the effect of *D. metal* biomass as soil amendment on the growth and physiology of a crop plant. The present study was thus carried out to assess the usefulness of dry biomass of *D. metal* as soil amendment and its effect on crop growth, yield and physiology of bell pepper.

MATERIALS AND METHODS

A trial was carried out in earthen pots of 28 cm diameter, each containing 5 kg of sandy loam soil having pH 7.8 and organic matter 0.69%. Available potassium and phosphorus in the soil were 302 mg kg^{-1} and 14.3 mg kg^{-1}, respectively. Above-ground parts of mature *D. metel* plants were collected from wastelands in Lahore, Pakistan and cut into small pieces of about 1.0 cm. After complete drying under the shade, the material was ground and mixed in the soil at 0.5, 1, 1.5, 2, 2.5 and 3% (w/w). Control pots were without *D. metel* biomass. After irrigation, pots were left for one week to start leaching and decomposition process of the mixed biomass of *D. metel.*

Nursery of bell pepper was raised by sowing surface sterilized (with 1% sodium hypochlorite solution for 3 minutes) seeds in earthen pots containing 3 kg sterilized soil in each pot. Six seedlings were transplanted after 6 weeks in each pot of the control and different treatments of dry biomass of *D. metel* (DBD). The experiment was conducted in a netting house using a completely randomized design with 6 replicates. Plants were harvested at maturity and data regarding various plant growth and yield attributes were recorded. Physiological studies like assessment of chlorophyll, carotenoid, phenolics and protein contents (Arnon, 1949; Lowry *et al.,* 1951; Bray and Thorpe, 1954), and evaluation of activities of different defense related enzymes like POX, PAL and CAT were carried out by taking three plant samples from each treatment at flowering stage and adopting standard procedures (Shoaib *et al.,* 2020). All the data were analyzed through one-way ANOVA followed by LSD test at P≤0.05 by using software Statistix 8.1.

RESULTS AND DISCUSSION

Effect of soil amendment on plant growth: ANOVA showed that the effect of different treatments was significant on all the growth and yield related parameters (Table 1).

Table 1: Analysis of variance (ANOVA) for the effect of dry biomass of *Datura metel* on different growth and yield parameters of bell pepper.

Sources of variation	Df	Mean squares					
		Shoot length	Shoot dry weight	Root dry weight	No. of fruits	Fresh weight of fruits	Dr weight of fruits
Treatments	6	236**	4711**	1162**	2.55*	3863*	54.4*
Error	35	39.79	340.5	9.72	2.01	2730	18.52
Total	41						

*, **, Significant at P≤0.05 and 0.001, respectively.

Soil amendment with DBD, especially its lower concentrations, markedly improved crop growth. Shoot length was increased by 9–44% due to different concentrations of DBD. The stimulatory effect of all the concentrations was significant (P≤0.05) except 0.5% and 3%. There was not a uniform pattern of increase in length with the increase in concentration of the DBD. There was a gradual increase in shoot length by 19–44% up to 1.5% concentration and a gradual decrease thereafter (Fig. 1A). Likewise, application of DBD markedly enhanced shoot dry weight by 29–45% due to 0.5 to 2% concentrations. The 2.5% concentration of DBD also increased shoot dry weight (23%) but the effect was less pronounced than the lower concentrations. By contrast, the highest concentration of DBD (3%) was inhibitory and reduced shoot dry weight of bell pepper by 62% over control (Fig. 1B). The effect of DBD application on root dry weight was also similar to the effect on shoot dry weight. There was 11–14% increase in root dry weight due to 0.5–2% concentrations of DBD. Conversely, 2.5 and 3% DBD reduced dry biomass of root by 4% and 48% over control, respectively (Fig. 1C). Like vegetative growth, reproductive growth of bell pepper, in terms of number and weight of fruit, was also increased gradually by increasing concentration of DBD up to 2% where 13–38%, 8–57% and 33–83% increase in number, and fresh and dry weights of fruit were recorded over control, respectively. A 3% DBD had adverse effect on

reproductive growth as compared to lower concentrations of DBD (Fig. 2 A-C). Addition of plant material to the soil has number of important functions for maintenance of soil quality such as improvement of soil structure and water infiltration rate (Martens, 2000). In addition, added plant residues possess a sufficient quantity of micro- and macro-nutrients (Mubarak *et al*., 2002), which are released in the soil during the nutrient recycling process and increase soil fertility (Lal, 2008), leading to increase crop growth and yield (Zhou *et al*., 2020).

In the present study, lower doses of DBD up to 2% generally enhanced plant growth and yield of bell pepper and the effect was gradually increased by increasing concentration of DBD while 3% concentration of DBD markedly suppressed plant growth and yield. Earlier, similar stimulatory effect of lower concentrations and inhibitory effect of higher concentration of an asteraceous weed *P. hysterophorus* has been reported on the growth of rice (Javaid *et al*., 2009). Both *P. hysterophorus* and *D. metel*are allelopathic in nature (Ramachandran, 2017; Shi and Adkin, 2020). Allelochemicals may stimulate plant growth when they are present in low concentrations while their higher concentrations are mostly inhibitory to seed germination and plant growth. In the present study, it is highly likely that in 2% and lower doses of DBD, the added weed biomass provided not only the nutrient released from decomposing materials but also the lower concentrations of leached out allelochemicals stimulated plant growth. In contrast, higher doses of allelochemicals in 3% dose of DBD adversely affected crop growth and yield.

Effect of soil amendment on plant physiology: The effect of treatments was significant for chlorophyll and phenolic contents but not for protein content. Likewise, the effect of treatments was also significant for PPO and PAL and insignificant for PAL (Table 2).

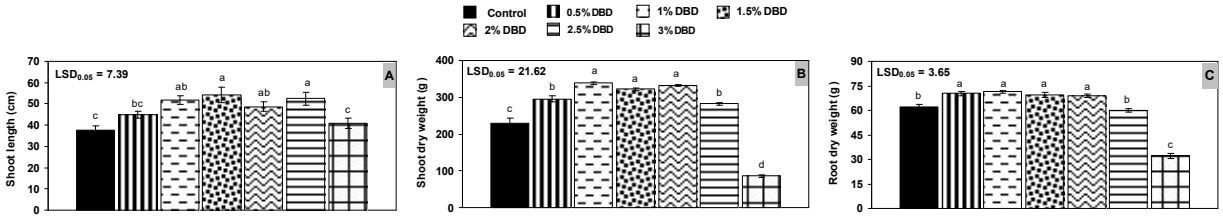

Fig. 1: Effect of soil amendment with dry biomass of *Datura metel* (DBD) on shoot and root growth of bell pepper. Vertical bars show standard errors of means of six replicates. Values with different letters at their top show significant differences (P≤0.05) as determined by LSD Test.

Table 2: Analysis of variance (ANOVA) for the effect of dry biomass of *Datura metel* on different growth and yield parameters of bell pepper.

Sources of variation	df	Mean squares					
		Chlorophyll content	Protein content	Phenolic content	POX	PPO	PAL
Treatments	6	0.0011*	0.0008 ns	0.000054*	0.013*	0.0053**	0.00005ns
Error	14	0.0011	0.0025	0.000053	0.010	0.0002	0.00013
Total	20						

POX: Peroxidase activity, PPO**:** Polyphenol oxidase activity, PAL**:** Phenylalanine ammonia lyase activity
*, **, Significant at P≤0.01 and 0.001, respectively.
ns: Nonsignificant

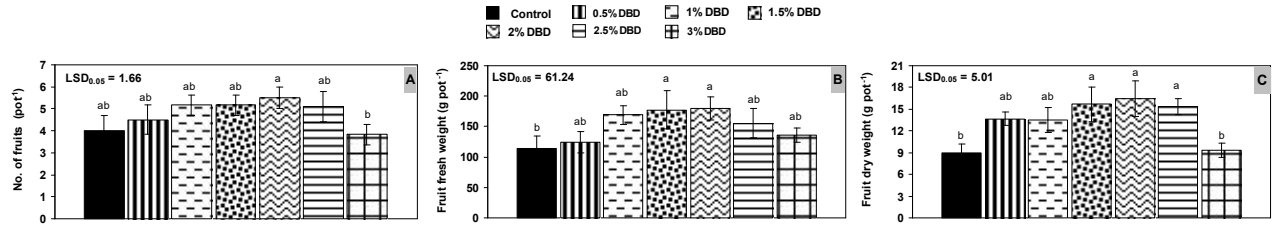

Fig. 2: Effect of soil amendment with dry biomass of *Datura metel* (DBD) on number and biomass of fruits of bell pepper. Vertical bars show standard errors of means of six replicates. Values with different letters at their top show significant differences (P≤0.05) as determined by LSD Test.

Chlorophyll content was significantly (P≤0.05) increased by 0.5% DBD over control. However, a further increase in the concentration of DBD gradually decreased this parameter and the difference was insignificant over control (Fig. 3A). The lowest concentration of 0.5% of DBD markedly decreased protein content that was gradually increased with increasing concentration of DBD. However, statistically the effect of DBD on protein content was insignificant (Fig. 3B). The highest phenolic content was recorded in control. DBD application gradually reduced this parameter with an increase in its concentration and the negative effect of 2.5% DBD was significant as compared to control (Fig. 3C). The effect of DBD application on activities of various defense-related enzymes was variable. The effect was insignificant in case of POX and PAL activities. Likewise, lower concentrations of 0.5–2% of DBD showed an insignificant effect on PPO activity while 2.5 and 3% concentrations significantly improved this parameter over control (Fig. 4). Soil amendment with dry biomass of DBD insignificantly affected most of the plant physio-chemical attributes probably due to availability of desirable physical environment (soil particle aggregation, water-holding capacity, cation exchange capacity, nutrient availability and microbial activity) for the plant to have normal development. At higher level of soil amendment, the said physio-chemical attributes exhibited increase, which might indicate stress condition in the plant due to allelopathic effect of dry biomass of DBD. It has been reported that inhibitory alkaloids in allelochemicals can disturb physiological processes like photosynthesis by inhibiting water absorption, which in turn can disturb the activity of enzymes (Sakadzo *et al*., 2018).

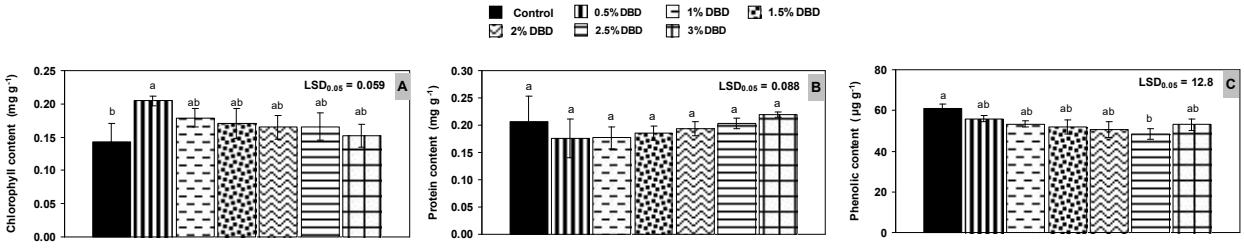

Fig. 3: Effect of soil amendment with dry biomass of *Datura metel* (DBD) on leaf chlorophyll, protein and phenolic contents of bell pepper. Vertical bars show standard errors of means. Values with different letters at their top show significant differences (P≤0.05) as determined by LSD Test.

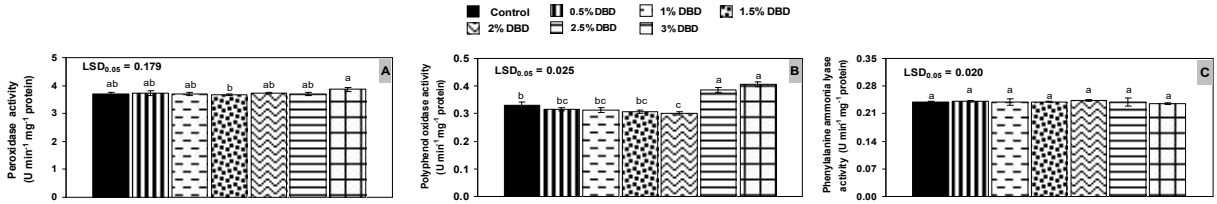

Fig. 4: Effect of soil amendment with dry biomass of *Datura metel* (DBD) on the activity of defense-related enzymes in leaves of bell pepper. Vertical bars show standard errors of means. Values with different letters at their top show significant differences (P≤0.05) as determined by LSD Test.

Conclusion: This study concludes that the application of 2% dry biomass of *D. metel* as soil amendment can significantly enhance growth and yield of bell pepper.

Conflict of interest disclosure: The authors declare no conflict of interest.

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