Expedition ***PLANT*** : ***P***lant ***L***ife ***A***llelopathy in ***N***orth-eastern ***T***urkey

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Introduction and Aims

Alellopathy is an ecological phenomenon in which two or more plant species interact biochemically in a fashion that ultimately results in the inevitable inhibition of one of species. It is worth noting that allelopathy in all of its degrees of severity must not be confused by any means with another ecological phenomenon known as exploitative competition which also leads to the inhibition of growth and other plant properties. The key distinctive feature that makes these two processes fundamentally different is the pure chemical nature of allelopathy; a plant synthesising allelochemicals supresses the growth of another species not by the means of competition for light or mineral compounds but just by inhibiting a whole range of essential biochemical pathways in the donor species. For instance, the aromatic compound juglone produced by the Black American walnut (*Juglans nigra*) seems to be capable of supressing the growth of any seeds or spores that have had the bad luck to be spread nearby the tree as it strongly inhibits the respiratory metabolism of variety of plant cells.

Since allelochemicals are either soil-borne or air-borne, and research in the subsequent edaphic factors defining the rates and severity of allelopathy has never been carried out to the best of my knowledge, the expedition aims were focused on the impact of these factors on allelopathy; more specifically, whether and if so then how soil bulk density (DBD) and porosity influence the inhibition observed as a result of soil-borne allelochemicals.

Methods

The methodology of the expedition was sustainable, with no major negative effects on the Turkish vegetation cover and ecosystem balance. The formula for measuring the allelopathic severity was one of the key problems of the research as this has never been done before; however, the final formulation that I suggested for being most adequate is as follows:

$$\text{Index of allelopathic severity} = \frac{\textbf{Population density of the dominant allelopathy-potent species}}{\textbf{Number of potential recipient species}}$$

where the *"Number of potential recipient species"* represents the total number of plant species different than the dominant allelopathic plant i.e. other herbaceous plants, bushes and trees found in the small square areas (usually 5x5 square metres) employed for the experimental observations and statistics. These indexes were then analysed and put in the context of soil DBDs and porosities measured consequently for the different areas used during the expedition. The final results were tabulated and graphically represented in the Result section of the report. Statistics were estimated using the standard student t-test, checking for the scientific importance and reliability of the data obtained.
The figures of the soil DBDs were obtained by a fairly standardised procedure that is Thermal Processing including the collection of a soil sample with a certain volume, taking a reading of the mass of the unprocessed sample, "baking" in an oven at a temperature of over 100 degrees Celsius for 2 hours and then taking a final reading of the soil sample mass thus deducing the relevant DBD values.

Results

Two main allelopathic donor species were used in the final experimental design. This has been based upon the need of receiving more consistent and statistically-verifiable results. These two species are Guinea grass (*Panicum maximum*) and Johnson grass (*Sorghum halepense*), both from the grass family (*Poaceae*) as well as being very well known for their pest and allelopathic properties (see Figure 1).
As typical pests, these plants were found to grow normally in various soil types and environmental conditions. This presented the opportunity of plotting the allelopathic rates of these two donor species under the conditions offered by the following four different standard soil types:

1. grey podsolic soils;
2. brown clayey soils;
3. brown peaty soils;
4. coarse sandy soils;

all of which demonstrated different values of DBDs and porosities thus fulfilling the requirement of variable edaphic factors under

Figure 1. The two species of high allelopathic potential – Guinea grass and Johnson grass. Photo taken by the author.

which the severity of allelopathy can be compared to.
Table 1 shows a very condensed summary of the main piece of data collected during the expedition as it contains the allelopathic indexes of the two species compared under different soil conditions.

Table 1. Allelopathic indices of the two dominant species – Guinea grass and Johnson grass measured under different edaphic (soil) conditions.

Plant species	Allelopathic index	Soil type	DBD	Porosity
Guinea grass	1.10	1	1.15 g/cm^3	53%
Guinea grass	1.63	2	1.20 g/cm^3	56%
Guinea grass	2.15	3	1.35 g/cm^3	51%
Guinea grass	2.66	4	1.05 g/cm^3	45%
Johnson grass	1.21	1	1.20 g/cm^3	54%
Johnson grass	1.59	2	1.25 g/cm^3	57%
Johnson grass	2.44	3	1.30 g/cm^3	48%
Johnson grass	2.79	4	1.10 g/cm^3	45%

Subsequently, the data shown have been plotted so that the dependency between the allopathic index on one side, and the soil DBD and porosity, on the other, could be established (see Figure 2 & Figure 3).

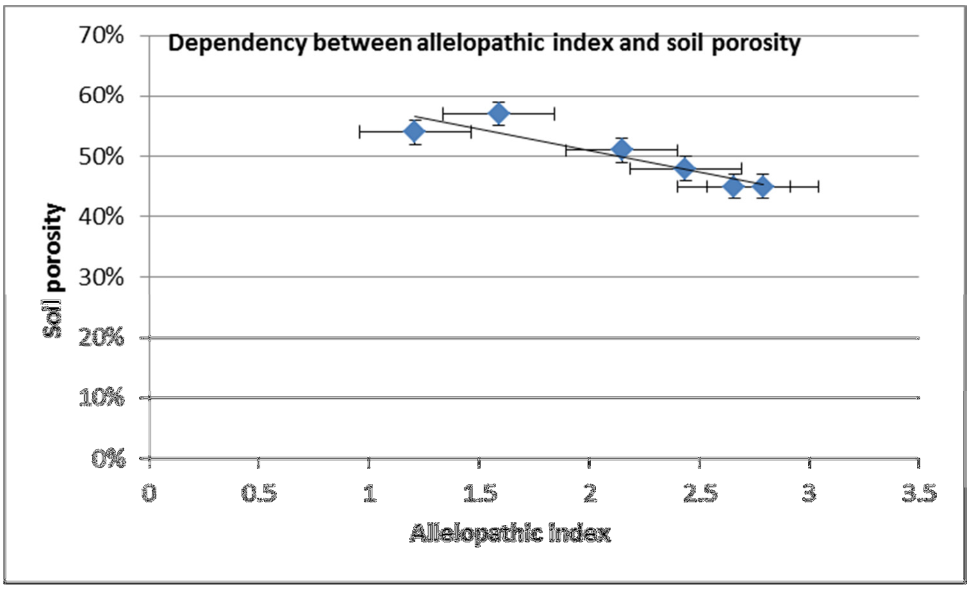

Figure 2. Graphic dependency between allelopathic index and soil porosity: the graph shows the linear dependency between the two measures which demonstrated a significant statistical difference ($p < 0.05$) when statistical tests were performed (Student's t-test).

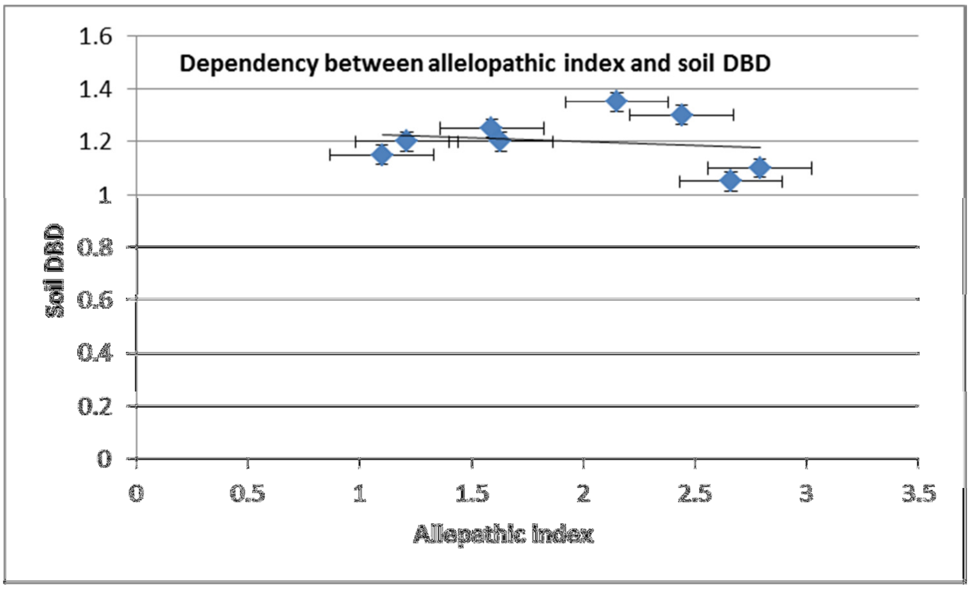

Figure 3. Graphic dependency between the allelopathic index and soil DBD: the graph: no significant statistical difference has been detected (p ›› 0.05).

Discussion and Conclusions

With our results collected and analysed, it seemed reasonable to argue that the severity of allelopathy between the dominant allelopathic donor species and its recipient plant species is reversely proportional to the porosity of the soil. On the contrary, allelopathic effects seem to be independent on the soil DBD, or at least not directly, since there is a well-recorded cross-talk between porosity and DBD which contribute to the characteristics of each soil type. However, it is worth-noting that our research could be enhanced if more plant species were analysed and if the exact reasons behind the observed dependency between porosity and the allelopathic index were revealed further. Nevertheless, we suggest that it is likely that the higher the porosity, the better the permeability and follow-on transport of allelochemicals in the gradient from dominant donor species to its recipient neighbours; this might suffice to explain our results. Future research on this topic should address the mechanisms behind these now well-established dependency as well as to check if this case study and its results are valid in the more general case – e.g. when the dominant species are eudicots, when they have been a subject of other environmental factors, including more soil types and subtypes etc. Only then, the knowledge gathered could be of any significant contribution towards common agricultural pests – most of which are highly potent allelopathic species.

Personal Statement

The expedition has helped me develop new practical and theoretical skills. In addition, the research results have been challenging to analyse as usually field science differs greatly from simply reading the textbooks, where all things are made to sound so easy. In other words, expedition *PLANT* taught me to appreciate the enormous efforts that have been invested into the data we are privileged to be aware of nowadays, data behind which hide years and years of hard scientific work. Furthermore, I have been significantly enriched culturally as Turkey offered a great deal of new contacts, sights, and amazing nature.

Summary

Virtually most pest plant species have some allelopathic potential that is their ability to biochemically suppress the growth of their plant neighbours. In agriculture, these neighbours often happen to be the crops themselves and as a result, yields can be severely decreased as a consequence of allelopathic interactions. Our findings suggest that soil porosity has a profound effect on the outcome of allelopathy, and can therefore be utilised as a reliable instrument acting to reduce the losses in crop yields. Nevertheless, more research is required before any applicable methods can be successfully developed.

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