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Sedaxane: Towards a New Concept in Plant Protection?

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For the past 50 years, both agrochemical companies and the public sector have been trying to identify molecules that have biostimulating activity in agriculture. Biostimulants are compounds which, when applied to cultivated plants, have positive effects on their physiology and/or their metabolism. Despite the extensive research, very few products have been identified as having reproducible biostimulating effects in both controlled and field conditions. With this in mind, BIOtransfer's research team has undertaken various studies on sedaxane, the new active fungicidal ingredient belonging to the chemical group Pyrazoles-carboxamides (SDHI, group C2: Complex II, Succinate dehydrogenase. FRAC codes list© 2011). BIOtransfer's in-depth research has brought to light an unexpected and more than interesting effect that sedaxane has on the plant. The first in-laboratory results obtained by BIOtransfer are described in this article as follows.

Implemented Methodological Approach

Because sedaxane is a seed treatment compound, we first looked for an experimental methodology that would allow wheat plant germination and growth visualization in standard conditions. We decided to use large tubes in which wheat seeds would be germinated individually, allowing regular growth of the wheat during a 60-day period. Two common wheat cultivars (*Triticum aestivum*) were used in this study: an alternative, Inoui (C.C. Benoist), and a ½ winter, Isengrain (Florimond Desprez). The compound was applied as seed treatment by means of a Hege Bowl, at the rate of 10 g a.i./q (dose given by VIBRANCE Gold, approved preparation). To avoid any interference with fungal pathogens present in the soil (clay, pH 7.7), it was sterilized twice at a 24-hour interval. Sterilized soil was then mixed with extra-fine vermiculite at a 75:25 (v/v) ratio so as to allow better aeration of the substratum. Unprotected and protected seeds were sown one centimeter deep (one seed per tube).
Then the outside wall of each tube was covered with aluminum foil so that roots would develop in the dark like they would in a field. Each tube was watered weekly with 10 ml of a 0.25 g/l nutrient solution (N-P-K, 20-20-20). The tubes (30 per condition) were then placed in a phytotron with the following temperature and light conditions:

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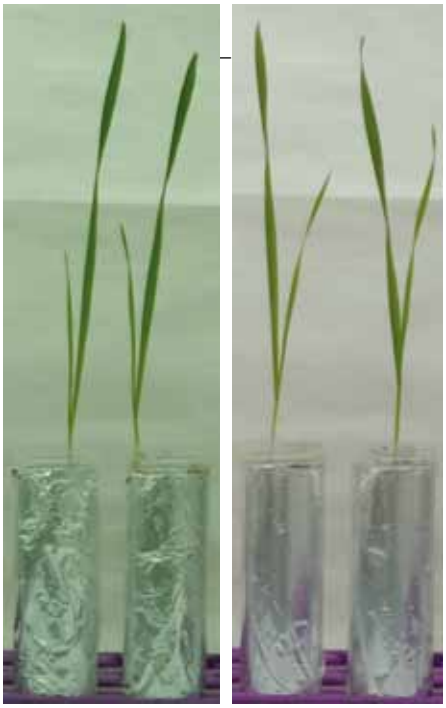
– one month at 20°C day/17°C night and a photoperiod of 14h light/10h darkness;
– one month at 14°C day/9°C night and a photoperiod of 12h light/12h darkness.
Observations were made 3, 4, 5, 10, 17, 30 and 60 days after sowing. The various parameters analyzed were:
– Number of emergent seedlings at the surface of the substratum 3, 4 and 5 days after sowing;
– Height of wheat plants 10, 17, 30 and 60 days after sowing;
– Fresh weight of the shoot system 30 and 60 days after sowing;

Experimental device: wheat seedlings (to the left cultivar Inoui, to the right cultivar Isengrain) growing in sterilized ground in plastic tube. The aluminum foil placed outside of the tube, guarantees that the roots would develop in the dark as in the field.



Length and the fresh weight of the root system 30 and 60 days after sowing.
The Newman-Keuls method (XL-Stat software, Addinsoft Ltd) was used to compare the various conditions tested.

Primary Results Obtained

Effect of sedaxane on wheat seedling emergence

For seeds of common wheat cultivar Inoui protected with 10 g a.i./q of sedaxane, about 12% of the seedlings appeared at the soil surface three days after sowing, while no seedlings were observed from unprotected seeds (Figure 1a). Four days after sowing, we still noted a difference of emergence, but it was no longer statistically significant. After five days of incubation, there was no difference in the rate of emergence of wheat seedlings between both analyzed modalities. Consequently, 90% of the wheat seedlings appeared at the soil surface, whether seeds were protected with sedaxane or not.
Concerning seeds of common wheat cultivar Isengrain protected with 10 g a.i./q of sedaxane, about 60% of the seedlings appeared at the soil surface three days after sowing, while at the same time only 35% of the seedlings resulting from unprotected seeds emerged (Figure 1b). Four days after sowing, the difference between both tested modalities had already ceased to be visible. So, more than 95% of the wheat seedlings appeared at the soil surface, whether seeds were protected with sedaxane or not.

Effect of sedaxane on shoot system development of wheat seedlings

As shown in Table 1, the protection of seeds of common wheat cultivar Inoui with 10 g a.i./q of sedaxane led to a slight increase in shoot system height 17 and 30 days after sowing.
However, this increase was temporary because it was not observed 60 days after sowing. Similar results were also observed on the shoot system of seedlings of common wheat cultivar Isengrain resulting from seeds protected with sedaxane (Table 2).

Effect of sedaxane on the fresh weight of the shoot system of wheat seedlings

The protection of the seeds of common wheat cultivar Inoui with 10 g a.i./q of sedaxane (expressed as mg of fresh weight) led to a very clear increase in the shoot system biomass of the wheat seedlings, to the order of 12% at 30 days and of 18% at 60 days after sowing (Table 2a).
For the common wheat cultivar Isengrain, such an increase in the shoot system biomass of seedlings resulting from seeds protected with 10 g a.i./q of sedaxane was also observed, but only at 60 days after sowing (Table 2b).

Figure 1 *- Comparison of the emergence rate of wheat seedlings cultivar Inoui (a) and Isengrain (b) originating from unprotected seeds or protected with 10 g a.i./q of sedaxane. Values between brackets for the same incubation time followed by the same letter are not significantly different according to the Newman-Keuls test (P < 0.05).*

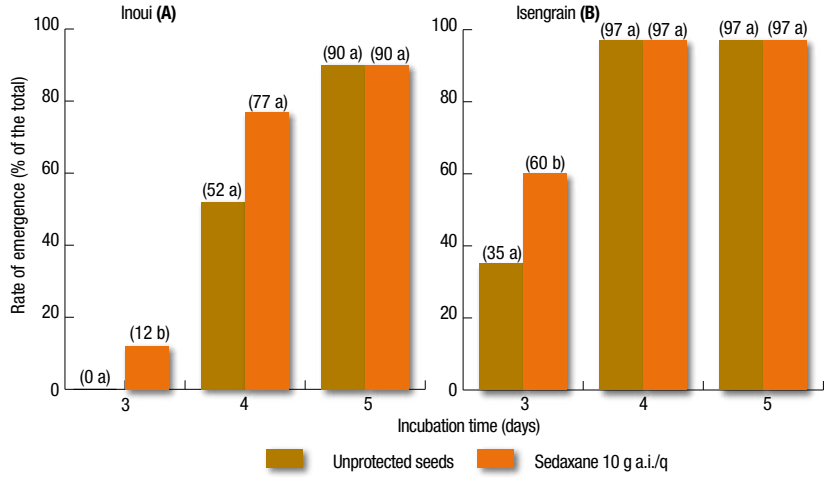


Figure 2 *- Comparison of the shoot system biomass of wheat seedlings cultivar Inoui (a) and Isengrain (b) originating from unprotected seeds or protected with 10 g a.i./q of sedaxane. Values between brackets for the same incubation time followed by the same letter are not significantly different according to the Newman-Keuls test (P < 0.05).*

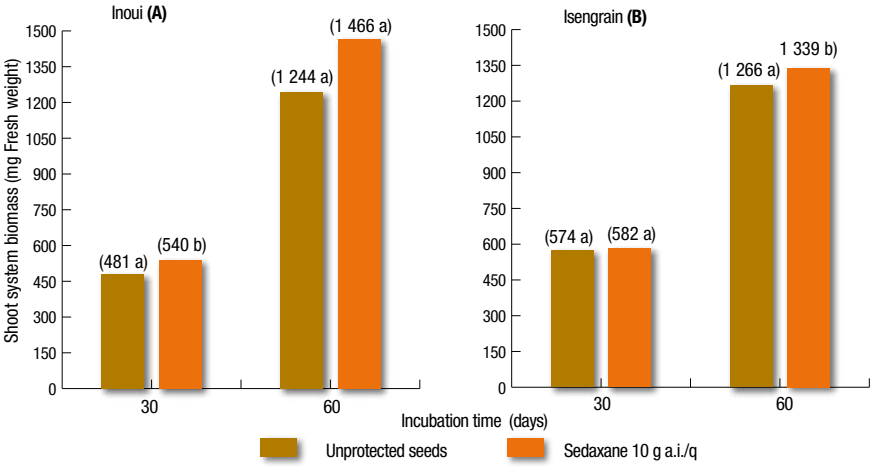


Table 1 - Effect of the protection of common wheat seeds cultivar Inoui with sedaxane (10 g a.i./q) on the shoot system development of seedlings cultivated in controlled conditions.

Treatment	Height of shoot system (cm)			
	10 dps[a]	17 jps	30 jps	60 jps
Unprotected control	16.7 a[b]	23.2 a	34.4 a	43.7 a
sedaxane (10 g a.i./q)	16.8 a	25.4 b	36.8 b	45.3 a

[a] dps : days post sowing.
[b] Each value corresponds to the mean of 60 observations per treatment at 10, 17 and 30 dps and of 30 observations per treatment at 60 dps. Values in the same column by the same letter are not significantly different according to the Newman-Keuls test(P < 0.05).

Table 2 - Effect of the protection of common wheat seeds cultivar Isengrain with sedaxane (10 g a.i./q) on the shoot system development of seedlings cultivated in controlled conditions.

Treatment	Height of shoot system (cm)			
	10 jps[a]	17 jps	30 jps	60 jps
Unprotected control	18.5 a[2]	28 a	38.4 a	44 a
Sédaxane (10 g a.i./q)	17.5 b	28.7 ab	40.8 b	44.6 a

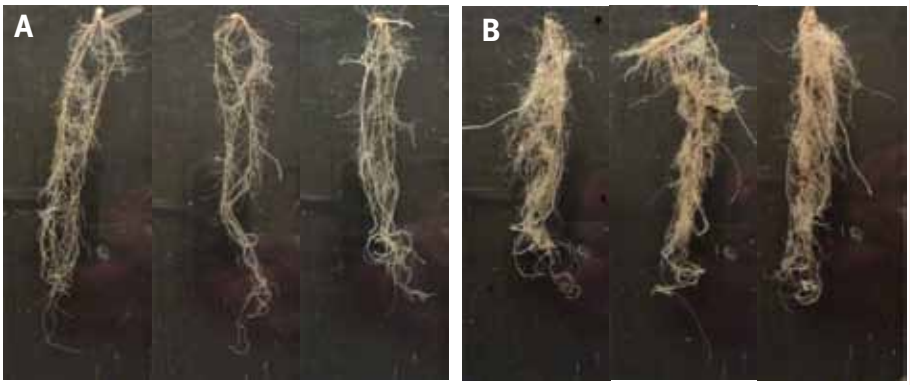
[a] dps : days post sowing.
[b] Each value corresponds to the mean of 60 observations per treatment at 10, 17 and 30 dps and of 30 observations per treatment at 60 dps. Values in the same column by the same letter are not significantly different according to the Newman-Keuls test (P < 0.05).

Effect of sedaxane on root system development of wheat seedlings

Two criteria were taken into account here to estimate the effect of sedaxane on root development: the length of the main roots (expressed in cm) and the fresh weight of the whole root system.

Roots of the seedlings of common wheat cultivar Inoui resulting from seeds protected with 10 g a.i./q of sedaxane seemed slightly longer than those of seedlings resulting from unprotected seeds 30 days after sowing (Figure 3a). It is important to note that such a difference in the length of the main roots between the two modalities disappeared after 60 days of incubation. On the other hand, sedaxane use led to a clear increase of the root system biomass when compared with the unprotected control of wheat seedlings 30 —but also— 60 days after sowing (Figure 4a). So, sedaxane applied to seeds of cultivar Inoui led to an increase in the root system biomass by more than 85% when

Photos 1A & B. *General aspect 60 days after sowing of the root of common wheat seedlings cultivar Inoui resulting from unprotected seeds (a) or protected with 10 g a.i./q of sedaxane (b). We note the remarkable homogeneity between replicates of the same modality. The lateral root system appears denser on wheat seedlings resulting from seeds protected with sedaxane. On the other hand, the length of the main roots is comparable on seedlings protected or not with sedaxane.*



Photos 2A et B. *General aspect 60 days after sowing of the root of common wheat seedlings cultivar Isengrain resulting from unprotected seeds (a) or protected with 10 g a.i./q of sedaxane (b). We note the remarkable homogeneity between replicates of the same modality. The lateral root system appears denser on wheat seedlings resulting from seeds protected with sedaxane. On the other hand, the length of the main roots is comparable on seedlings protected or not with sedaxane.*

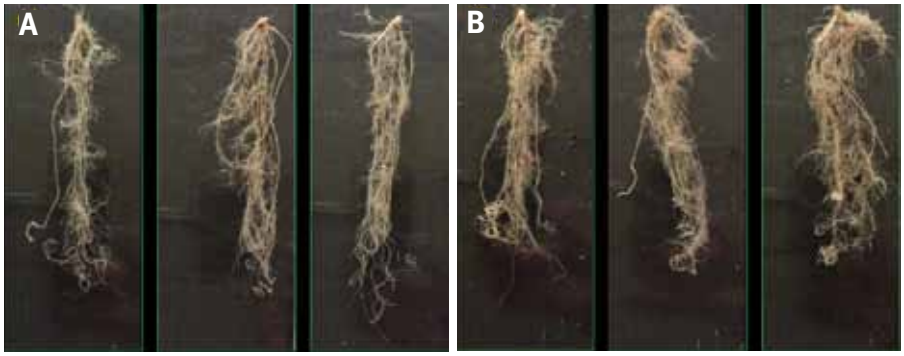


Figure 3 *- Comparison of the root system length of wheat seedlings cultivar Inoui (a) and Isengrain (b) originating from unprotected seeds or protected with 10 g a.i./q of sedaxane. Values between brackets for the same incubation time followed by the same letter are not significantly different according to the Newman-Keuls test (P < 0.05).*

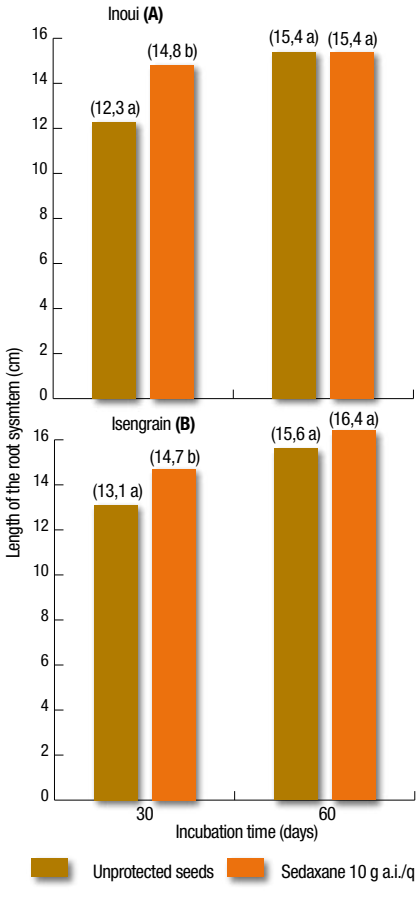
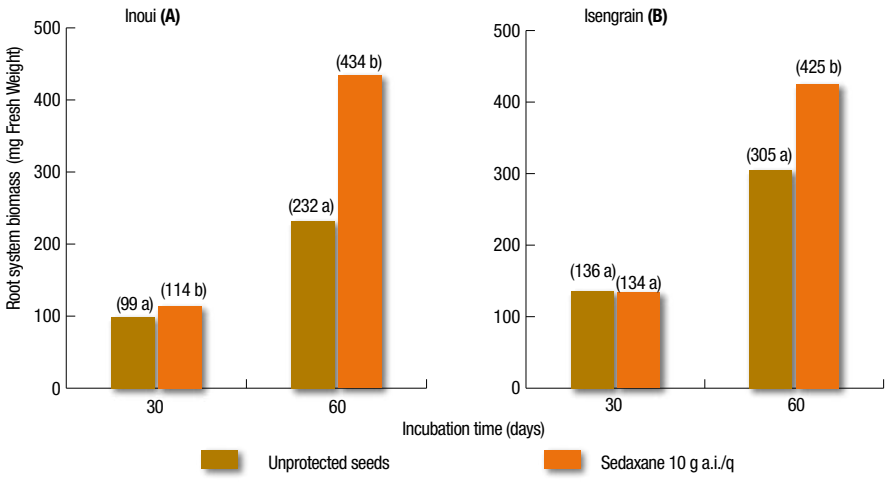


Figure 4 *- Comparison of the root system biomass of wheat seedlings cultivar Inoui (a) and Isengrain (b) originating from unprotected seeds or protected with 10 g a.i./q of sedaxane. Values between brackets for the same incubation time followed by the same letter are not significantly different according to th Newman-Keuls test (P < 0.05).*



compared with the unprotected control 60 days after sowing (Photos 1a and b).
For the common wheat cultivar Isengrain, the length of the roots of seedlings resulting from seeds protected with 10 g a.i./q of sedaxane was slightly higher than that for the seedlings resulting from unprotected seeds 30 days after sowing (Figure 3b). This difference disappeared 60 days after sowing: the roots of wheat seedlings, whether or not they were protected with sedaxane, had appreciably the same length.
It is interesting to note that sedaxane clearly increased the root system biomass by about 40% as compared with the unprotected control, but only 60 days after sowing (Figure 4b, Photos 2a and b).

In conclusion

In controlled conditions, we have demonstrated that sedaxane when applied as seed treatment at 10 g a.i./q (dose given by VIBRANCE Gold, approved preparation), had a highly reproducible effect on the root biomass, most particularly on the proliferation of the lateral roots of wheat seedlings 60 days after sowing. This result was statistically significant on both tested cultivars of common wheat, with a greater effect on the cultivar Inoui (an about 87% increase in root system biomass) than on the cultivar Isengrain (about 40%). We can ask ourselves if such differences observed with both of these cultivars of common wheat are fortuitous or if they are genetically linked. To answer this important question, it is necessary to study the effect of sedaxane applied as seed treatment at 10 g a.i./q on other cultivars of common wheat.
Sedaxane also seems to have a positive effect on the seedling vigor of both of these common wheat cultivars by accelerating their rates of emergence. It is important to make clear that for these two cultivars, the effect of sedaxane on the root system biomass has no negative incidence on the shoot system development of seedlings. It seems that protecting seeds with 10 g a.i./q of sedaxane leads to a slight increase in the fresh weight of the shoot system, at least temporarily.
These original results raise, of course, a certain number of questions:
– i) What is the mechanism at the origin of such an increase in root biomass? It seems that this phenomenon is limited to the lateral roots because the length of the main root is not affected. Studies are underway in order to understand the effects of sedaxane applied as seed treatment at the cellular and molecular levels.
– ii) Can such modifications of the root system have an incidence on wheat plant yield? This question would suggest experiments in controlled conditions in order to avoid any interference with a possible fungicidal effect on plant pathogens present in the soil. Seeds and young plants are potentially affected by multiple stresses: biotic (i.e., microorganisms) as well as abiotic (i.e., moisture, nutrition, temperature). The most susceptible stages for plants are, obviously, seeding, emergence and the first growth stages of their development. Any increase in the root system biomass, at least during this critical period, can only be beneficial to the plant in surmounting the possible stresses which could occur during the season.
Clarifying sedaxane's mode of action could lead to the development of a new concept of seed and root system protection for cultivated plants: especially since diseases caused by telluric pathogens («Soil Borne Diseases») have been appearing in South America (Sclerotinia, Pythium, «Sudden Death Syndrome»), for example. These new approaches could present a major interest for the future of plant protection.

Summary

Sedaxane: towards a new concept in plant Protection?
Since 50 years, an active research is led by private companies and the public sector to identify molecules with biostimulating activity in agronomy. However, very few products were identified as having reproducible biostimulating effects in controlled conditions and in the field.
The research team of BIOtransfer brought to light an unexpected and interesting effect of sedaxane, a new fungicidal active ingredient belonging to the chemical family of Pyrazoles-carboxamides (SDHI, group C2 : Complexe II, Succinate dehydrogenase. FRAC code list 2011®), on plant.
In controlled conditions, sedaxane applied as seed dressing at 10 g/q (dose brought by Vibrance Gold®, approved preparation) increases very sharply the biomass of the root system of wheat seedlings cultivar Inoui (87%), as well as cultivar Isengrain (about 40 %), 60 days after sowing.
Furthermore, sedaxane seems to have a positive effect on the vigor of wheat seedlings of both cultivars by accelerating their rate of emergence.
On the other hand, the effect of sedaxane on the biomass of the root system of both wheat cultivars has no negative incidence on the development of the aerial part of wheat plants. On the contrary, it seems that seed dressing with 10 g/q sedaxane leads to an increase of the fresh weight of the aerial part of wheat plants, at least temporarily. The understanding of the mechanism of action of this molecule could lead to develop a new concept of protection of the seed and the root system of cultivated plants.

Résumé

Depuis 50 ans, une recherche active est menée par les grands groupes et le secteur public afin d'identifier des molécules à caractère biostimulant dans le domaine agronomique. Cependant, très peu de produits ont été identifiés comme ayant des effets biostimulants reproductibles en conditions contrôlées et en plein champ.
L'équipe de recherches de BIOtransfer a mis en évidence un effet inattendu et intéressant du sédaxane, nouvelle substance active fongicide appartenant à la famille chimique des pyrazoles-carboxamides (SDHI, group C2 : Complexe II, Succinate dehydrogenase. FRAC code list 2011®), sur la plante.
En conditions contrôlées, le sédaxane appliqué en protection des semences à 10 g/q (dose apportée par Vibrance Gold, préparation homologuée) augmente de façon très nette la biomasse racinaire de plantules de blé 60 jours après semis, et ce aussi bien chez la variété de blé tendre Inoui (87 %), que chez la variété Isengrain (près de 40 %). De plus, le sédaxane semble également avoir un effet positif sur la vigueur des plantules de ces deux variétés de blé tendre en accélérant leur taux d'émergence.
D'autre part l'effet du sédaxane sur la biomasse du système racinaire de ces deux variétés de blé tendre n'a pas d'incidence négative sur le développement des parties aériennes des plantules. Bien au contraire, il semble même que la protection des semences avec 10 g/q de sédaxane induise une augmentation du poids frais du système aérien des plantules, au moins temporairement.
La compréhension du mécanisme d'action de cette molécule pourrait conduire à développer un nouveau concept de protection de la semence et du système racinaire chez les plantes cultivées.

Ref. TAP 653 - 04

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a new concept in plant protection