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INVESTIGATIONS ON PREVENTING WHEAT PHYTOTOXICITY DUE TO MISAPPLIED GLYPHOSATE

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Abstract

Recently, some phytotoxicity problems are faced in wheat, cotton and maize crops, and vineyards which are caused by factors like misapplication of herbicides, drift or herbicide residues in treatment equipment. To reduce or limit the phytotoxicity, some cultural practices or activators are offered by some dealers, however, whether these methods are really suitable to recover the phytotoxicity or not, still remain unclear. In order to investigate this issue, some pot experiments were conducted. Wheat plants were at first treated with 5 doses of glyphosate (Roundup Star) corresponding 12.5, 25, 50, 100 and 200% of the recommended dose (3.0 l/ha). Eight hours after treatments, some activators were used in different combinations. To assess the injury of wheat plants, phytotoxicity symptoms were observed weekly for four weeks long visually and percent injuries were recorded. In addition to that plant vegetation index, stomatal functions and chlorophyll contents of plants were measured. As the results it was observed that the activators did not cause any positive recovery of affected wheat plants, so that their use is not recommended in case of glyphosate injury to wheat plants. Special attention should be paid to avoid misapplications.

Keywords: *Glyphosate, phytotoxicity, activator, wheat, recovery.*

Introduction

During the last a few years, some phytotoxicity problems from herbicides have been noted in crops like vineyard, maize, cotton and wheat. These phytotoxicity problems probably resulted from drift, herbicide residues in the sprayer and use of non-recommended herbicide dose. Such wrong applications of herbicides result in the crop yield losses. Several studies report the negative effects of drift and the use of non-recommended herbicides on the crops (Moffett et al., 1980; Street and Snipes, 1992; Sciumbato et al., 2004; Thomas et al., 2005). Although, the reports regarding the damages of misuse of herbicides are available in the literature, however, no studies report the solutions to tackle such problems. Glyphosate is one among the herbicides which are misapplied in the crop fields. Glyphosate is an enolpyruvyl-shikimate-phosphate (EPSP) inhibitor which inhibits the amino acids (Vencill, 2001). Some enzyme activators and organic fertilizers, if applied to plants receiving a misapplication of herbicides are supposed to get recover. The effectiveness of activator to reduce the phytotoxic effects results from the activity of harpin protein. Harpin protein are produced naturally in the crop plants, fruits, vegetables in response to stress, like pest attack. The harpin proteins strengthen the plant resistance against stresses and help the plants to draw more water and nutrients, improve the photosynthetic activity, enhance the plant growth and hence improve the crop yields (Anonymous, 2012a). Another activator groups is made of a special combination of Cu, Mn and Zn obtained after fermentation from microorganism and addition of organic matter. One of them has been found to be an effective material which reduces the

herbicide phytotoxicity in plants (Anonymous, 2012b). Some research work has been conducted regarding the effects of some activators to control the plants viruses (Çalışkan, 2007), fungus (Dereboylu and Tort, 2010) and bacteria (Soykan, 2010). The growers have no information regarding the strategies in response to phytotoxicity caused by herbicide drift, misapplication of herbicides and the residual effects of herbicides in the equipment. As no research has been done to tackle such kind of phytotoxicity, the growers facing such problems cannot be advised a solution. This results in harmful effects on produce as well as wastage of money.

In this research, we have determined the phytotoxic effects of misapplication different doses of glyphosate. Moreover, the effectiveness of some chemical activators to negate these phytotoxic effects has been evaluated.

Materials and methods

The research work was done two times during 2014 at the Faculty of Agriculture, Adnan Menderes University Aydin (Turkey). The wheat plants of variety Sagittario were grown in pots while a single plant was allowed to grow in each pot. Different doses of glyphosate herbicide (12.5 %, 25 %, 50 %, 100 % and 200 % of the recommended dose) were sprayed on wheat plants at the tillering stage (BBCH=22-23) in the morning time. The recommended dose of glyphosate was 3 Lt/ha. Each dose of glyphosate was applied on 20 wheat pots. Later, 5 out of 20 posts received no further treatment. The other pots (in a set of 5, making a total of three sets) were applied with Activator I (Agrozym^{TM}, 1 kg/ha), Activator I+Activator II (Flora X ^{TM}, 1 Lt/ha) and Activator I+Activator III (Messenger Gold ^{TM}, 60 g/ha) separately. Moreover, 5 pots received no treatment to act as control. These treatments were made 8 hours after the glyphosate application to combat the phytotoxicity caused by herbicide application. The phytotoxicity showed its symptoms one week after herbicide application, hence the effect was recorded 4 weeks after application. Water was used 200 L/ha for herbicide application while 110-03 fan type nozzle was used with spraying chamber.

Observation of phytotoxicity: The data on phytotoxicity was recorded comparing the respective treatments with the untreated control. The experiment was visited at one, two, three and four weeks after the treatments application. The phytotoxicity was recorded visually and expressed in percentage effect.

Determination of chlorophyll concentration index, vegetation index and stomatal conductance and dry weight: The data on the agro-physiological parameters of wheat was recorded six times during experiment; first, one day before the herbicide application; second, one day after herbicide application; and then every week for four times. The data recorded included parameters such as chlorophyll concentration index, vegetation index and stomatal conductance. The chlorophyll concentration index (CCI) was determined using Chlorophyll Meter (Apogee Company), vegetation index was determined by NDVI meter (QUBIT Z951 NDVI-Pen), and the stomatal conductance (mmol $m^{-2}s^{-1}$) was measured using leaf porometer (Model; SC-1, Decagon Devices, Inc.). All the wheat plants in pots were harvested 28 days after herbicide and activator application and dried in oven for 70 ^{o}C in two days to record the dry weight.

Results and discussion

Phytotoxicity: The applied doses of glyphosate differed in phytotoxicity (Table 1). The lowest phytotoxicity noted for the 12.5 % dose i.e. 12-14 % on 3 weeks after application and 25-30 % on 4 weeks after sowing (Table 1). The phytotoxicity caused by 50 % glyphosate dose was 38-42 % at 3 weeks after application and 44-74 % at 4 weeks after application. Further, no big difference was there for the phytotoxicity among the doses including 50 %, 100 % and 200 %. All of these doses (50, 100 and 200 %) gave nearly 80-90 % phytotoxicity at 3 weeks

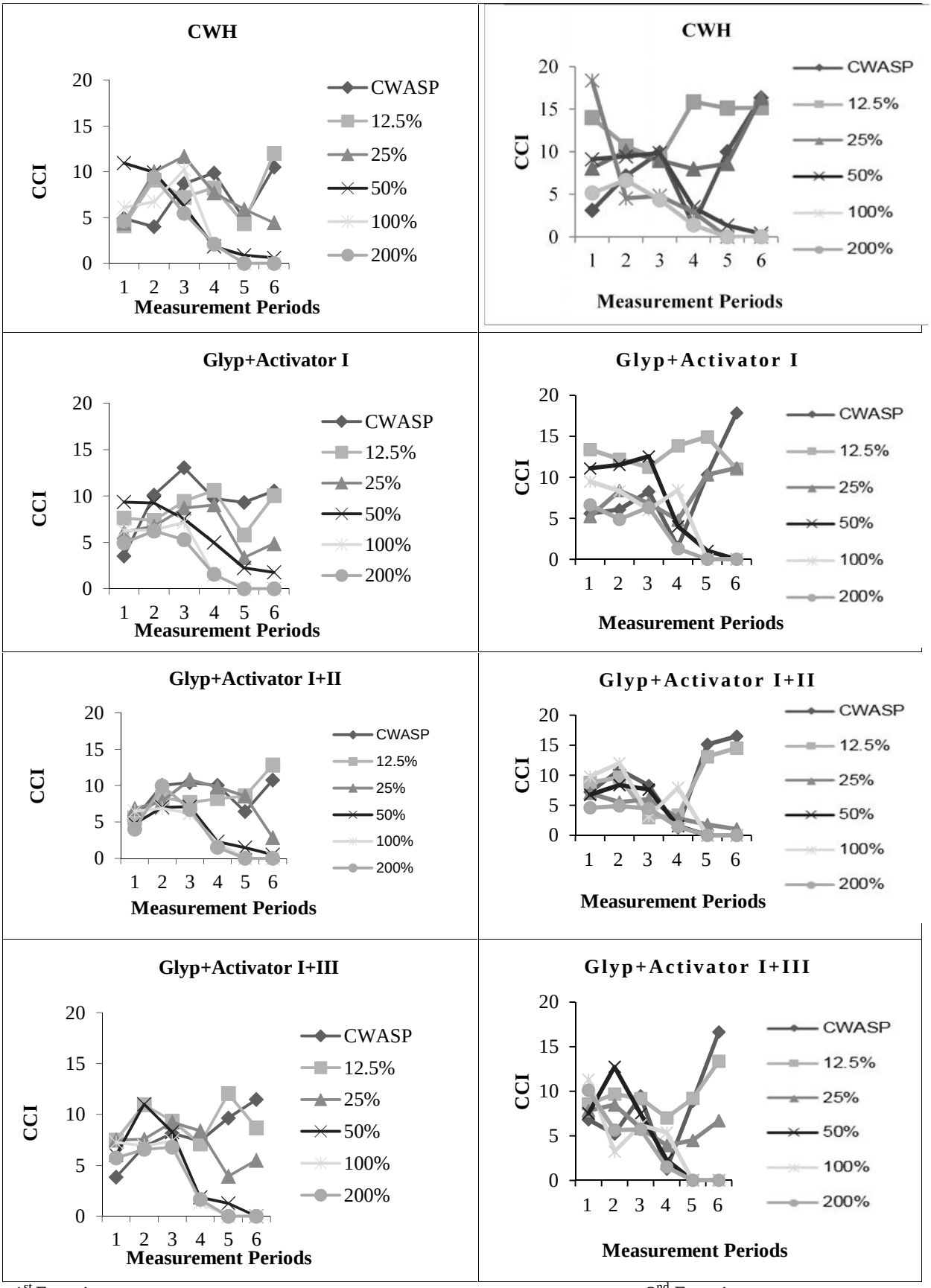
after application and 100 % phytotoxicity at 4 weeks after application (Table 1). Further, the results indicated the visual phytotoxicity on the wheat plants applied with either of the activators was similar as it was for the only herbicide applied wheat plants (Table 1).

Table 1.Phytotoxicity after application of different glyphosate doses

	Glyphosate		**Glyphosate+Activator I**		**Glyphosate +Activator I+II**		**Glyphosate +Activator I+III**	
Exp.	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Dose=12.5% (375ml/ha)								
1st week	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2nd week	6,0	1,8	2,8	0,0	2,2	5,0	3,2	4,0
3rd week	14	12	13	4,0	6,0	22	6,8	28
4th week	25	30	32	1,0	9,0	6,0	24	26
Dose=25% (750ml/ha)								
1st week	2,0	2,2	2,0	3,2	0,4	2,6	0,4	1,8
2nd week	4,8	24	7,8	22	2,2	58	9,4	22
3rd week	38	42	52	44	32	87	46	62
4th week	74	44	59	46	86	89	79	54
Dose=50% (1500ml/ha)								
1st week	5,0	0,4	2,6	1,2	3,8	7,4	2,2	4,4
2nd week	78	50	66	56,0	95	64	86	81
3rd week	88	88	66	98	82	100	94	100
4th week	100	100	97	100	98	100	100	100
Dose=100% (3000ml/ha)								
1st week	6,0	6,0	7,0	3,0	3,2	7,0	6,4	5,4
2nd week	89	90	95	90	89	90	91	90
3rd week	91	100	98	100	95	100	96	100
4th week	100	100	100	100	100	100	100	100
Dose=200% (6000ml/ha)								
1st week	4,2	9,0	4,8	9,0	5,8	8,0	5,8	8,0
2nd week	86	96	91	96	92	94	94	93
3rd week	93	100	96	100	95	100	96	100
4th week	100	100	100	100	100	100	100	100

Chlorophyll concentration index (CCI), vegetation index (NDVI) and stomatal conductance and dry weight: CCI for 12.5 % glyphosate dose was decreased at 7 and 14 days, and it was increased after 21 days. However, CCI was highly decreased after the application of 50 %, 100 % and 200 % doses at 7 days. As a result, the 12.5 % dose and control had same CCI, 25 % dose was similar with only herbicide, Activator I and Activator I+III. The results on NDVI indicated that in the two experiments, the 50 % and higher doses extremely decreased the NDVI after 7 days. The results for CCI were not consistent while the results for NDI were consistent and uniform. Similar to CCI and NDVI, in untreated control and 12.5 % dose stomatal conductivity was decreased between 7 and 14 days, afterwards, it was increased. All the applications of 25 % had a moderate effect. However, at 50 % and higher doses, stomatal conductivity was highly decreased after 7 days.

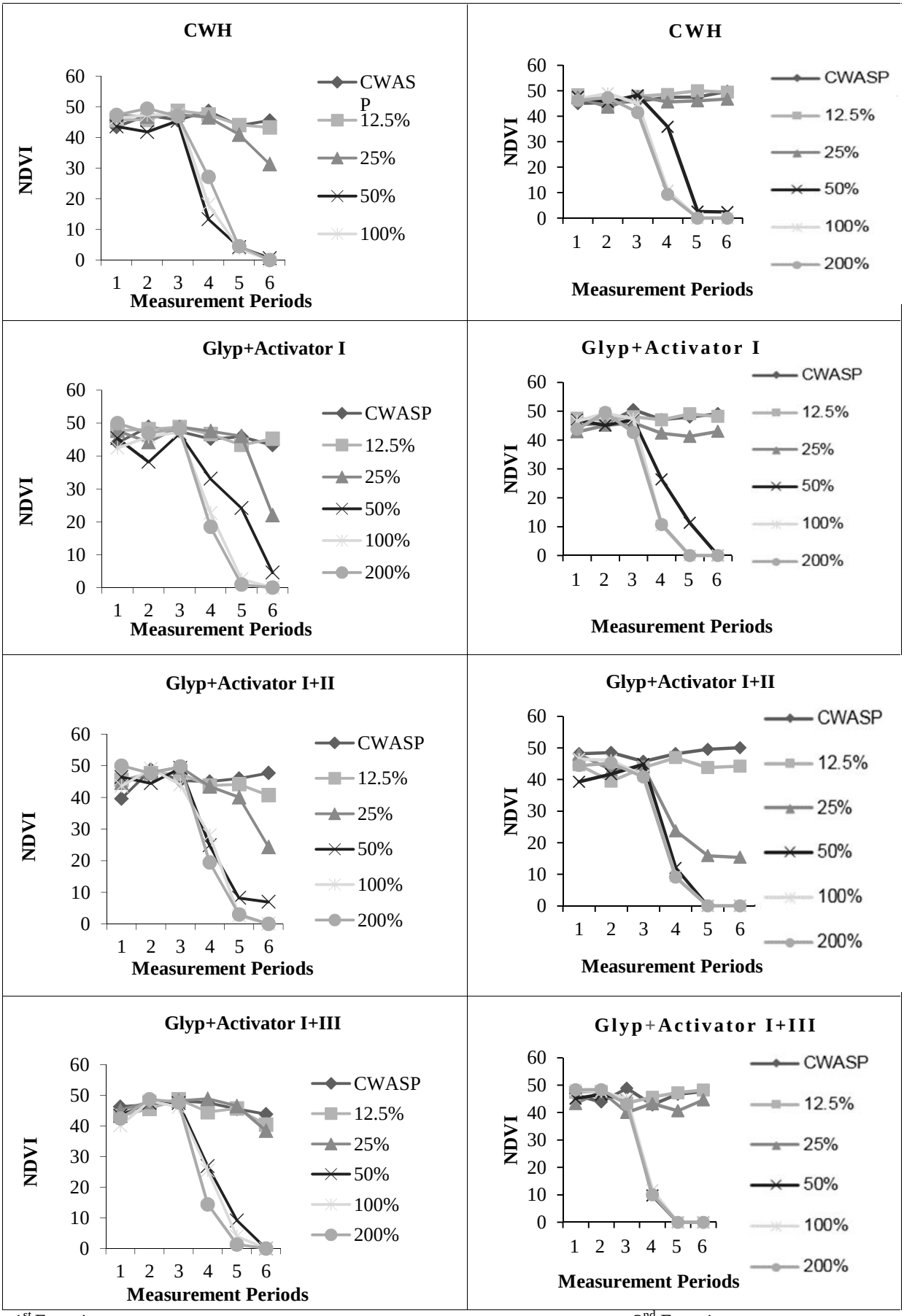
Regarding the dry weight, the data for the first and second experiments was different. But, the dry weight was decreased for 12.5 % and 25 % doses including for the plants applied with activators. For all the plants applied with 50 % or higher doses (with or without activator), no dry weight was recorded as the plant were died.



1st Experiment 2nd Experiment

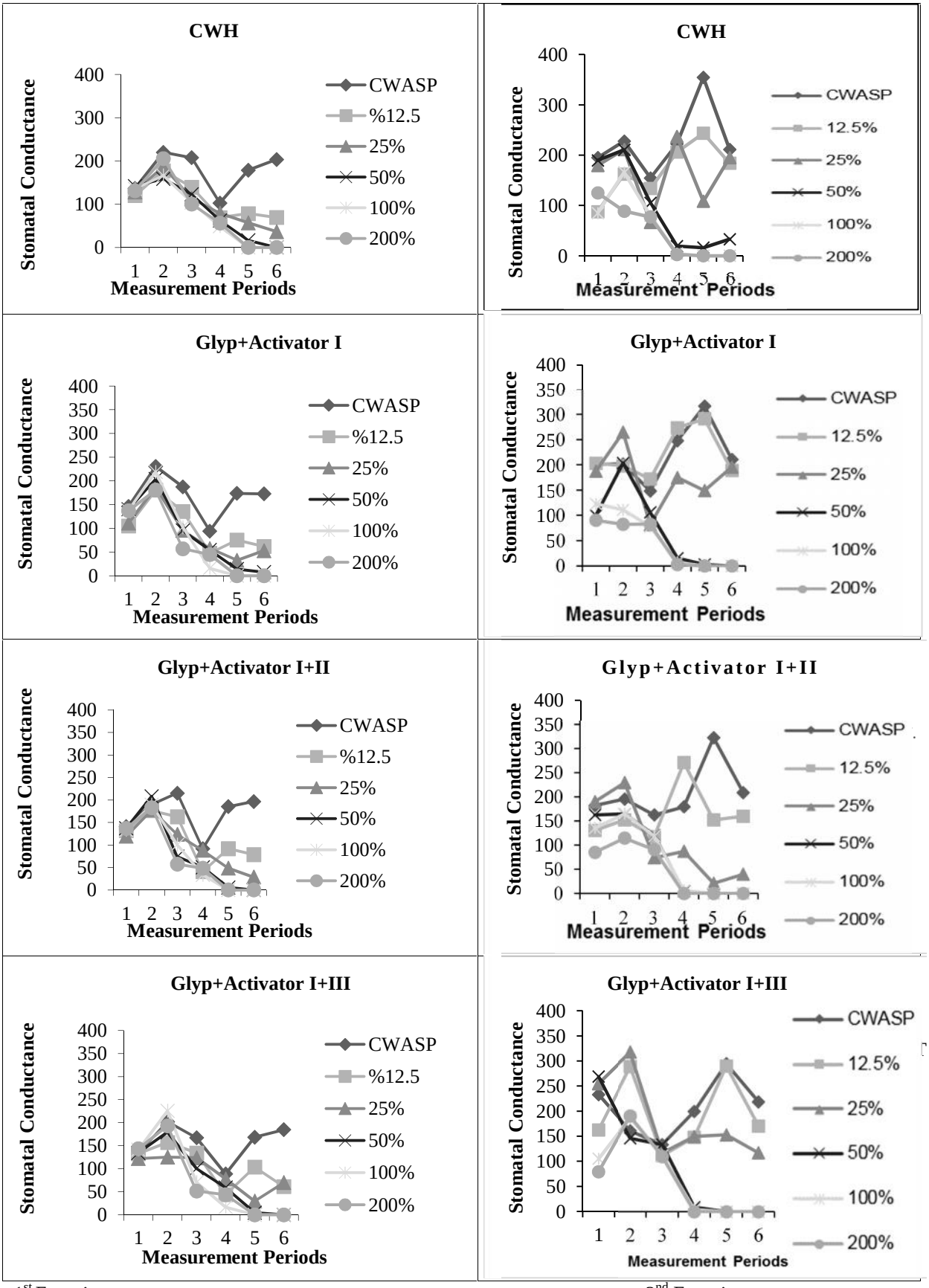
Figure 1. CCI before and after application of glyphosate and activators

Measurement periods were: 1=one day before application; 2=one day after application; 3 = 7 days after application; 4= 14 days after application; 5=21 days after application; 6=28 days after application



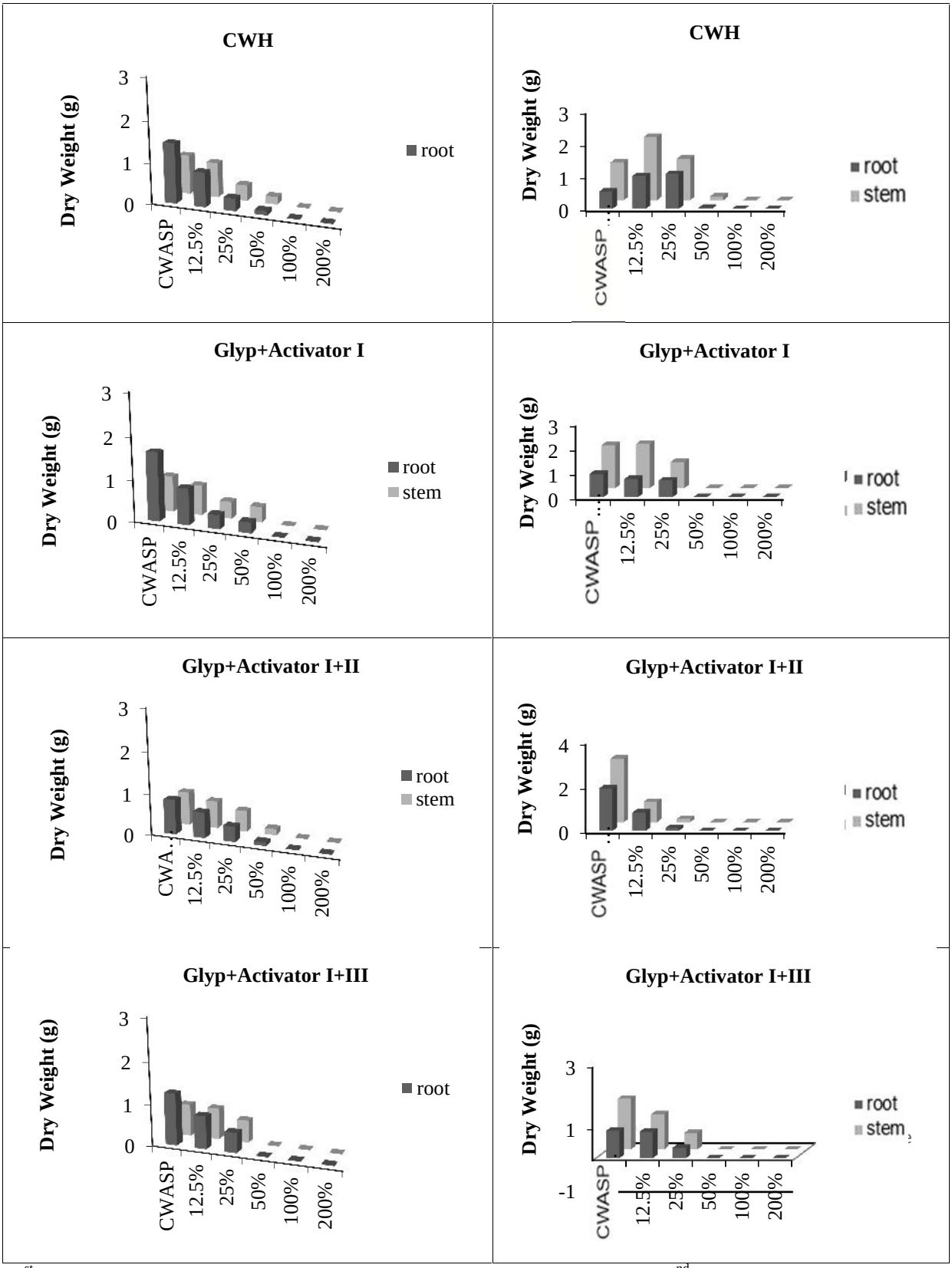
1st Experiment 2nd Experiment

Figure 2. NDVI before and after application of glyphosate and activators



1st Experiment 2nd Experiment

Figure 3. Stomatal conductance before and after application of glyphosate and activators



1st Experiment 2nd Experiment

Figure 4. Dry weight of wheat after application of glyphosate and activators

Conclusions

The results indicated that the activators did not cause any positive effect for the recovery of glyphosate affected wheat plants. Hence, the use of such chemical is not recommended in case of glyphosate injury (phytotoxicity) to wheat plants. Special attention should be paid to avoid misapplications.

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