RESEARCH ARTICLE

INTERACTIVE EFFECT OF AUXIN AND SIMULATED ACID RAIN ON THE FRESH WEIGHT AND DRY WEIGHT OF THE SEEDLINGS OF *CAPSICUM FRUTESCENS* VAR. *CALIFORNIA WONDER* AND *SWEET MAGIC*

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Abstract: Fresh weight and dry weight are important in deciding the growth of plants. They are related to health of plants. Therefore, studies have been carried out on dry weight and fresh weight of seedlings of *Capsicum Frutescens* var. *California wonder* and *Sweet magic* under the influence of simulated acid rain, auxin as well as interactive effect of both of them at different concentrations during present study and optimum concentration has been determined for the best growth.

Keywords : Simulated acid rain, Auxin , Fresh weight , Dry weight

INTRODUCTION

Health and growth of seedling decides future of plant. Crop yield of plants as well as their food value are decided by the dry weight and fresh weight of seedling. Germination and seedling growth are the factors on which the fresh weight and dry weight of seedling depend. Germination percentage is lower under highly acidic conditions i.e. pH 3.0 (M. Sharma, 2014; Kumar and Singh, 1987). Growth of root and shoot system decrease with increase in acidity in ground nut seedling (Anitha et al., 1992). Zabawi et al. (2008) also reported decrease in germination percentage at pH5.0. Germination and growth also decreased in grass at pH3.0 and pH5.0 (Simona et al., 2009). Hindwai et al. (1980) reported decrease in dry weight under acidic conditions which indicate that lesser germination percentage decreases dry weight. Ashenden and Bell (1989) observed reduction in total plant dry weight by 40% for *Vicia Feba*, 30% for *Pisum Sativum* and 28% for *Pisum Multflorus* when they were exposed to pH2.5 as compared to pH5.6. Hence, the dry weight and fresh weight are also related to germination and growth of seedling. Greater the pH, greater will be the growth of seedling as well as dry weight and fresh weight of seedling. In order to get greater yield in *Capsicum Frutescens*, dry weight and fresh weight under acidic conditions; in presence of plant growth hormone (Indole acetic acid, IAA) as well as interactive effect of both was studied. Acidic rain of pH3.0, pH4.0 and pH5.0, Auxin solution of the concentrations 1 x 10^{-5}, 1 x 10^{-6} and 1 x 10^{-7} M were used and combinations of pH and Auxin 3.0 + 1 x 10^{-5} M, 3.0+ 1 x 10^{-6} M, 3.0 + 1 x 10^{-7} M ; 4.0 + 1 x 10^{-5} M, 4.0 + 1 x 10^{-6}M ,4.0 +1 x 10^{-7} M and 5.0 + 1 x 10^{-5} M, 5.0 + 1 x 10^{-6} M and 5.0 + 1 X 10^{-7} were chosen for study.

MATERIAL AND METHOD

Seeds in experimental group were treated with acid rain, Auxin and combination of acid rain and Auxin, as per Table 1. After fifth day of radicle emergence, the seedling parts were dissected and parameters fresh weight and dry weight of radicle and plumule were determined.

Table 1.

1st set	Control- distilled water
2nd set	Acid rain - pH 3.0
3rd set	Acid rain - pH 4.0
4th set	Acid rain - pH 5.0
5th set	1x10^{-5} M Auxin
6th set	1x10^{-6} M Auxin
7th set	1x10^{-7} M Auxin
8th set	Acid rain pH 3.0 + 1x10^{-5}M Auxin
9th set	Acid rain pH 3.0 + 1x10^{-6}M Auxin
10th set	Acid rain pH 3.0 + 1x10^{-7} M Auxin
11th set	Acid rain pH 4.0 + 1x10^{-5} M Auxin
12th set	Acid rain pH 4.0 + 1x10^{-6} M Auxin
13th set	Acid rain pH 4.0 + 1x10^{-7} M Auxin
14th set	Acid rain pH 5.0 + 1x10^{-5} M Auxin

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15^{th} set	Acid rain pH 5.0 + $1x10^{-6}$ M Auxin
16^{th} set	Acid rain pH 5.0 +$1x10^{-7}$ M Auxin

Table 2. Effect of simulated acid rain (pH 3.0, 4.0, 5.0) on Fresh and Dry weight (mg ±SD) after 5th day of radicle emergence in the seedlings of *Capsicum frutescens* var. *california wonder* and *sweet magic*

Treatment	California wonder		Sweet magic	
	Fresh weight	Dry weight	Fresh weight	Dry weight
Control	499.8 ± 48.4	41.8 ± 4.6	392.9 ± 68.1	24.9 ± 5.7
3.0	194.3 ± 35.5	16.2 ± 3.0	201 ± 35.6	16.8 ± 3.0
4.0	286.8 ± 37.4	23.9 ± 3.1	290.8 ± 34.5	24.2 ± 2.9
5.0	392 ± 48	32.7 ± 4.0	318.8 ± 40.5	26.6 ± 3.4

Table 3. Effect of Auxin ($1x10^{-5}$, $1 x10^{-6}$, $1 x 10^{-7}$ M) on Fresh and Dry weight (mg ±SD) after 5th day of radicle emergence in the seedlings of *Capsicum frutescens* var. *california wonder* and *sweet magic*

Treatment	California wonder		Sweet magic	
	Fresh weight	Dry weight	Fresh weight	Dry weight
Control	499.8 ± 48.4	41.8 ± 4.6	392.9 ± 68.1	24.9 ± 5.7
$1x10^{-5}$ M	507.4 ± 83.9	42.3 ± 7.0	533.9 ± 62.6	44.5 ± 5.2
$1 x10^{-6}$ M	474.5 ± 77.6	39.5 ± 6.5	472 ± 22.7	39.3 ± 1.9
$1 x10^{-7}$ M	471.7 ± 75.7	39.3 ± 6.3	326 ± 60.0	27.2 ± 5.0

Table 4. Interactive effect of acid rain (pH 3.0,4.0 and 5.0) and Auxin ($1x10^{-5}$ $1 x10^{-6}$, $1x10^{-7}$ M) on Fresh and Dry weight (mg ±SD) after 5th day of radicle emergence in the seedlings of *Capsicum frutescens* var. *california wonder* and *sweet magic*

Treatment	California wonder		Sweet magic	
	Fresh weight	Dry weight	Fresh weight	Dry weight
Control	499.8 ± 48.4	41.8 ± 4.6	392.9 ± 68.1	24.9 ± 5.7
3.0 + $1x10^{-5}$ M	270.5 ± 55.7	22.5 ± 4.6	360 ± 15.5	30 ± 4.3
3.0 + $1x10^{-6}$ M	463.3 ± 48.6	38.6 ± 4.0	405.5 ± 58.9	33.8 ± 4.9
3.0 + $1x10^{-7}$ M	382.8 ± 65	31.9 ± 5.4	482.2 ± 91.1	40.2 ± 7.6
4.0 + $1x10^{-5}$ M	319 ± 71.1	29 ± 6.5	375.7 ± 54.8	34.2 ± 5.0
4.0 + $1x10^{-6}$ M	265.1 ± 17.7	22.1 ± 1.5	319.8 ± 96.5	26.7 ± 8.00
4.0 + $1x10^{-7}$ M	341.6 ± 39.6	28.5 ± 3.3	429.8 ± 75.3	35.8 ± 6.3
5.0 + $1x10^{-5}$ M	277.5 ± 64.0	23.1 ± 5.3	271.8 ± 53.4	22.6 ± 4.4

5.0 + $1x10^{-6}$ M	293.3 ± 50	24.4 ± 4.2	356.4 ± 83.6	29.7 ± 7.00
5.0 + $1x10^{-7}$ M	396.8 ± 59.1	33.1 ± 4.9	294.5 ± 294.5	24.5 ± 5.8

RESULT

Fresh and Dry weight of seedlings

Table-2 shows the effect of treatment of simulated acid rain of different concentrations (pH 3.0, 4.0 and 5.0) on fresh and dry weight of seedlings (Radicle and plumule) of *Capsicum frutescens* var. *California wonder* and *Sweet magic*. It is seen from the table that in var. *California wonder*, on treatment with simulated acid rain (pH 3.0, pH 4.0 and pH 5.0), fresh weight of the seedling is 38.88 %, 57.38 % and 78.43 % of control respectively. In case of dry weight, when the treatment of simulated acid rain (pH 3.0, pH 4.0 and pH 5.0) is given to the seedlings the dry weight is 38.76%, 57.17% and 78.23% of the control respectively.

In var. *Sweet magic*, fresh weight of seedlings is 51.15%, 74.00% and 81.12% of control respectively at the treatment of simulated acid rain (pH 3.0, pH 4.0 and pH 5.0). When the treatment of simulated acid rain of pH 3.0, pH 4.0 and pH 5.0 is given to the seedlings, the dry weight is 67.46 %, 97.18 % and 106.82 % of the control respectively.

Table-3 shows the effect of treatment of Auxin ($1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$ M) on fresh and dry weight of seedlings of *Capsicum frutescens* var. *California wonder* as well as *Sweet magic*. It is observed that when the treatment of $1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$ M concentration of auxin is given, the fresh weight of the seedling (radicle and plumule) is 101.52 %, 94.94% and 94.37 % whereas the dry weight is 101.19 %, 94.49 % and 94.02% of the control respectively in var. *California wonder*.

In var. *Sweet magic*, Fresh weight of seedlings at the treatment of $1x10^{-5}$, $1x10^{-6}$, $1x10^{-7}$ M is 135.88%, 120.10% and 82.95% of control respectively while at the same treatment, the dry weight is 178.71%, 157.83 % and 109.23% of the control respectively.

Table-4 expresses the Interactive effect of treatment of simulated acid rain and auxin on fresh and dry weight of seedlings (Radicle and Plumule) of *Capsicum frutescens* var. *California wonder* and *Sweet magic*. In var. *California wonder*, when the seeds are treated with simulated acid rain and auxin (pH 3.0+$1x10^{-5}$ M, pH 3.0+$1x10^{-6}$ M, pH 3.0 + $1x10^{-7}$M), the fresh weight is 54.12 %, 92.70 % and 76.59 % of the control respectively. Upon being treated with simulated acid rain and auxin (pH 4.0+$1x10^{-5}$ M, pH 4.0+$1x10^{-6}$ M, pH 4.0+$1x10^{-7}$ M), the fresh weight is 63.83 %, 53.04 % and 68.35 % of the control respectively. At the treatment of simulated acid rain and auxin (pH 5.0+$1x10^{-5}$ M, pH 5.0+$1x10^{-6}$ M, pH 5.0+$1x10^{-7}$ M), the fresh weight is 55.52 %, 58.68 % and 79.39 % of the control respectively.

When the seeds are treated with simulated acid rain and auxin (pH 3.0+$1x10^{-5}$M, pH 3.0+$1x10^{-6}$ M, pH 3.0 + $1x10^{-7}$M), the dry weight is 53.83 %, 92.34 % and 76.32 % of the control respectively. When the treatment of simulated acid rain and auxin (pH 4.0+$1x10^{-5}$ M, pH 4.0+$1x10^{-6}$ M, pH 4.0+$1x10^{-7}$M) is given to the seeds, the dry weight is 69.38 %, 52.87 % and 68.18 % of the control respectively. At the treatment of simulated acid rain and auxin (pH 5.0+$1x10^{-5}$ M, pH 5.0+$1x10^{-6}$ M, pH 5.0+$1x10^{-7}$M) to the seeds, the dry weight is 55.26 %, 58.37 % and 79.19 % of the control respectively.

In var. *Sweet magic*, it is seen that when the seeds are treated with simulated acid rain and auxin (Ph3.0+$1x10^{-5}$M, pH 3.0+$1x10^{-6}$ M, pH 3.0 + $1x10^{-7}$M), fresh weight is 91.60 %, 103.18 % and 122.7 % of the control respectively. At the treatment of simulated acid rain and auxin (pH 4.0+$1x10^{-5}$ M, pH 4.0+$1x10^{-6}$ M, pH 4.0+$1x10^{-7}$M), the fresh weight is 95.60 %, 81.37 % and 109.36 % of the control respectively. At the treatment of simulated acid rain and auxin (pH 5.0+$1x10^{-5}$ M, pH 5.0+$1x10^{-6}$ M, pH 5.0+$1x10^{-7}$ M), the fresh weight is 69.16 %, 90.69 % and 74.94 % of the control respectively.

When the seeds are treated with simulated acid rain and auxin (pH 3.0+$1x10^{-5}$M, pH 3.0+$1x10^{-6}$ M, pH 3.0 + $1x10^{-7}$M), the dry weight is 120.48 %, 135.74 % and 161.44 % of the control respectively. When the treatment of simulated acid rain and auxin (pH 4.0+$1x10^{-5}$ M, pH 4.0+$1x10^{-6}$M, pH 4.0+$1x10^{-7}$M) is given to the seeds, the dry weight is 137.34%, 107.22 % and 143.77 % of the control respectively. At the treatment of simulated acid rain and auxin (pH 5.0+$1x10^{-5}$ M, pH 5.0+$1x10^{-6}$ M, pH 5.0+$1x10^{-7}$ M), the dry weight is 90.76%, 119.28 % and 98.39 % of the control respectively.

DISCUSSION

Fresh and dry weight of seedling also show declining trend as the acidity of rain increases in var. *california wonder* as well as *sweet magic*. In var. *california wonder*, on treatment with simulated acid rain (pH 3.0, 4.0 and 5.0), fresh weight of the seedling is 38.88%, 57.38% and 78.43% of control respectively. In case of dry weight, when the treatment of simulated acid rain (pH 3.0, 4.0 and 5.0) is given, the seedling growth is 38.76%, 57.17% and 78.23% of the control respectively.

In var. *sweet magic*, fresh weight of seedlings is 51.15%, 74.00% and 81.12% of control respectively on the treatment with simulated acid rain of pH 3.0, 4.0 and 5.0. The values of dry weight of seedlings for this variety recorded on treatment with simulated

acid rain of pH 3.0, 4.0 and 5.0 are 67.46%, 97.18% and 106.82% of control respectively.

In this study, results of effect of acid rain on fresh weight and dry weight of seedlings are supported by the results of the researchers Fan, et. al. (2000) on fine hardwood species; Lee and Weber (1979) and Shelburne *et. al.* (1993).

Dry as well as fresh weight of seedling (i.e. radicle and plumule) in var. *california wonder* are highest at $1x10^{-5}$ M. At $1x10^{-6}$ M and $1x10^{-7}$ M concentration, they decrease in order of concentration when comparison is done with control. The percentage of dry weight and fresh weight with respect to control is 101.52% and 101.19% at $1x10^{-5}$ M auxin, 94.93% and 94.49% at $1x10^{-6}$ M Auxin, 94.38% and 94.02% at $1x10^{-7}$ M. This data indicates that water retention capacity in all the seedlings produced by germination of soaked seed at $1x10^{-5}$ M, $1x10^{-6}$ M and $1x10^{-7}$ M is the same. In *sweet magic* variety also, trend for fresh weight and dry weight are same but magnitudes of dry weights are much higher than control. The effect is less pronounced at $1x10^{-7}$ M auxin. It is clear from data here that fresh weights and dry weights of seedlings are also variety specific.

The increase in dry matter of the seedlings obtained from IAA soaked seeds may be due to rapid cell division, enlargement of cells and accumulation of building units (Mostafa and Alhamd, 2011). However, the effects are not directly related to auxin concentration (Taylor,1938).

Fresh as well as dry weight of seedling in var. *California wonder* [radicle+plumule] is highest at the combination pH $3.0+1x10^{-6}$ M and lowest at pH $4.0+1x10^{-6}$ M auxin. Optimum concentration for fresh weight is pH $3.0+1x10^{-6}$ M, where the fresh weight is 93.7% of control. Therefore, visible consequence is that destructive effect of acid rain on the growth of plant cannot be totally overcome by auxin of $1x10^{-6}$ M level. In var. *sweet magic*, highest fresh weight is at pH $3.0+1x10^{-7}$ M auxin and minimum value has been found at pH $5.0+1x10^{-5}$ M. For dry weight in var. *sweet magic* the most effective concentration is pH$3.0+1x10^{-7}$ M of auxin and least effective is pH$5.0+1x10^{-5}$ M auxin. Thus effect of combination is again variety specific.

CONCLUSION

Fresh weight as well as dry weight decrease under highly acidic condition i.e. at pH 3.0. Auxin increases dry weight and fresh weight and damaging effect of acidic rain can be controlled through auxin to some extent. Optimum combination of pH and auxin concentration for fresh weight is $3.0 + 1x\ 10^{-6}$ M in *california wonder* and for *sweet magic* it is $3.0 + 1x\ 10^{-7}$ M . Thus interactive effect is variety specific.

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