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Relative efficiency of phytohormones and their application methods for enhancing the caryopsis developmentin oat

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Abstract

The present study reports the effect of different phytohormones (auxins and gibberellins) on the development of caryopsis in eight genotypes of oat crop. Four treatment of different combination and concentration of phytohormones were used. Along with this, two methods of application of these four treatments were observed. The phytohormone treatment of 2,4-D and GA_3 at the rate 50 ppm each in form a solution when applied directly to the pistil in form of a droplet in the floret was found to be the best treatment for obtaining succulent caryopsis.

Introduction

Wide hybridization with maize pollen is an important tool for the induction of haploid embryos in hexaploid oat(Marcińska*et al*, 213). Induction of haploid embryos followed by chromosome doubling techniques are an important breeding tool for the generation of instant homozygosity in a segregating plant (Nowakowska*et al*, 2015). Such crosses are prone to endosperm collapse even if the rare event of zygote formation occurs.As there is no endosperm formation even in the case of a successful fertilizationdifferent phytohormones are used for stimulation of a pseudo-seed/caryopsis which is critical for the rescue of developing haploid embryo (Rines&Dahleen, 1990). Accurate dosage and application of a phytohormoneplays an indispensable role in haploid embryo induction and its rescue in oat. Four phytohormone

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treatments were studied to stimulate pseudo seed formation and to withstand the effects of endosperm collapse after zygote formation as there is no endosperm formation in case of zygote formation followed by Uniparental genome elimination of alien pollen chromosomes following wide hybridization for haploidy induction. Along with these four phytohormone treatments of the solutions, two methods of application were also studied.

Material and methods

Genotypes:

The experimental material for the study included eight oat genotypes viz. PLP 1, HJ 8, Kent, RO 19, OS 6, HFO 114, F_1 (PLP1 × HJ 8) and *Avena sterilis.*

Location: Palampur, HP(32° 6' 37.9512" N and 76° 32' 10.4064" E.)

Year: *rabi*2016-17

Phytohormones:

Phytohormones and their concentration are provided in table 1

Method of phytohormone application

Two methods were deployed for the application of the four treatment of phytohormones

1. **Culm method:** The solution of the phytohormone was injected in the uppermost hollow cavity of the culm's internode. The internode was pierced with a syringe in the upper part of the internode and then the syringe with the injector were used to fill the cavity by inserting it at the lower end of the cavity until the solution leaked from the upper

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piercing. The piercings were then sealed using a commonly available petroleum jelly. This was repeated for three days after the pollination with the alien pollen for each treatment.

2. **Floret method:** The phytohormone treatment was directly applied to the gynoecium by gently opening the individual floret and the filling it with the phytohormone treatment. This was equivalent to placing a drop of the hormone on the stigma of the floret.

Results

The results are provided in figure 1 and figure 2. Treatment 1 consisted of 2,4-D at 100 ppm concentration. A total of 154 panicles were treated post pollination with 871 florets. Number of caryopsis obtained per floret (C/F %) was 225 with a percentage of 25.95. the magnitude of caryopsis development was higher in magnitude for floret mode of application with average C/F % of 45.21 as compared with 17.70 % C/F for mode of application by culm method.

Treatment 2 consisted of GA3 at 100 ppm concentration. A total of 145 panicles with 807 florets were pollinated and treated. An overall efficiency of 18.34 C/F % was obtained out of which C/F % for culm application was 10.67 and C/F % for floret application was 33.33.

Treatment 3 consisted of a mixture of 2,4-D and GA3 in solution form at 50 ppm each. In this case 148 panicles with 799 florets were pollinated and treated. Out of these, 245 caryopseswere obtained at a C/F % efficiency of 30.66 which was highest among all the treatment. Of the two methods of mode of application, C/F % for floret application was 61.08 which was the highest of all the treatments and methods whereas C/F % of culm application was 17.67 %.

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Treatment 4 consisted of a solution of 2,4-D and GA3 at concentrations of 100 ppm each. In this case 171 panicles with 991 florets were treated after pollination. The efficiency of obtaining caryopsis per florets was the lowest among all the treatment and methods with a value of 7.97 %. For culm application, the C/F % was 3.65 and for floret application C/F % was 19.13.For the application methods the % C/F ratio was higher for the floret method in combination with all the treatments.

Discussion

The above-mentioned results are in agreement with previous which have shown a solution of 2,4-D and GA3 as the most effective phytohormone treatment for obtaining caryopsis in oat crop (Warchoł, 2016; Sidhu, 2006). The mode of application of phytohormones reported in literature generally consist of spraying the pistils with the phytohormones till they are dripping wet for 2 days after pollination but a greater efficiency was reported by direct application of phytohormone to the pistil in an uncut floret by droplet method for 2 to 3 days after pollinationbut this method is highly labor intensive and a worker can only use this method over a limited number of florets (Warchoł, 2016; Sidhu, 2006). There is no reported use of injecting of the phytohormone to the topmost internode of culm in oat and this has been observed as an inefficient method for application of the phytohormone treatment for pseudo-seed development.

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Table 1: Phytohormones and their concentration:

Treatment	Phytohormone treatment	Concentration
1	2,4-D	100 ppm
2	GA3	100ppm
3	2,4-D+GA3	50 ppm each
4	2,4-D+GA3	50 ppm each

2,4-D = 2,4-Dichlorophenoxyacetic acid

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GA3 = Gibberellic acid

Figure 1: Effects of phytohormones and their method of application on caryopsis development in oats

Effects of phytohormones and their method of application on caryopsis development

Phytohormone (Auxin/Gibberellic Acid)	2,4-D					GA3					2,4-D + GA3					2,4-D + GA3				
Conc.	*100 ppm*					*100 ppm*					*50 ppm each*					*100 ppm each*				
Genotypes	Mode Of Application	Panicles	Florets	Caryopsis	C/F(%)	Mode Of Application	Panicles	Florets	Caryopsis	C/F(%)	Mode Of Application	Panicles	Florets	Caryopsis	C/F(%)	Mode Of Application	Panicles	Florets	Caryopsis	C/F(%)
PLP 1	Culm	22	107	22	20.56	Culm	17	83	5	6.02	Culm	9	52	9	17.30	Culm	15	111	4	3.60
	Floret	8	34	14	41.18	Floret	5	29	8	27.59	Floret	6	27	17	62.96	Floret	6	36	10	27.78
HJ 8	Culm	20	102	19	18.63	Culm	15	81	4	4.94	Culm	11	56	11	19.64	Culm	15	119	2	1.68
	Floret	6	32	12	37.50	Floret	8	47	15	31.91	Floret	5	29	19	65.51	Floret	9	38	9	23.68
KENT	Culm	9	43	7	16.28	Culm	14	77	0	0.00	Culm	17	93	21	22.58	Culm	10	61	0	0.00
	Floret	4	22	11	50.00	Floret	6	34	12	35.29	Floret	7	33	21	63.63	Floret	7	25	6	24.00
RO 19	Culm	11	98	14	14.29	Culm	9	51	8	15.69	Culm	17	83	15	18.07	Culm	19	85	5	5.88
	Floret	5	33	14	42.42	Floret	4	32	11	34.38	Floret	6	27	19	70.37	Floret	5	34	4	11.76
OS 6	Culm	8	31	4	12.90	Culm	10	52	9	17.31	Culm	16	79	14	17.72	Culm	22	125	6	4.80
	Floret	4	26	12	46.15	Floret	7	41	12	29.27	Floret	5	39	22	56.41	Floret	8	48	6	12.50
HFO 114	Culm	15	93	16	17.20	Culm	16	84	13	15.48	Culm	20	97	12	12.37	Culm	22	105	2	1.90
	Floret	7	37	17	45.95	Floret	7	36	12	33.33	Floret	7	41	26	63.41	Floret	7	44	9	20.45
F_2 (PLP 1 × HJ 8)	Culm	11	54	9	16.67	Culm	5	36	7	19.44	Culm	6	41	8	19.51	Culm	6	42	2	4.76
	Floret	7	40	18	45.00	Floret	3	17	5	29.41	Floret	3	17	3	17.64	Floret	4	23	3	13.04
A sterilis	Culm	9	82	17	20.73	Culm	14	70	11	15.71	Culm	8	59	9	15.25	Culm	11	66	5	7.58
	Floret	8	37	20	54.05	Floret	5	37	16	43.24	Floret	5	26	19	73.07	Floret	5	29	6	20.69
Σ		154	871	226	25.95		145	807	148	18.34		148	799	245	30.66		171	991	79	7.97
	% C/F (Culm Application)		17.70				% C/F (Culm Application)		10.67			% C/F (Culm Application)		17.67			% C/F (Culm Application)		3.64	
	% C/F (Floret Application)		45.21				% C/F (Floret Application)		33.33			% C/F (Floret Application)		61.08			% C/F (Floret Application)		19.13	

Figure 2: Relative efficiency of phytohormones and application method

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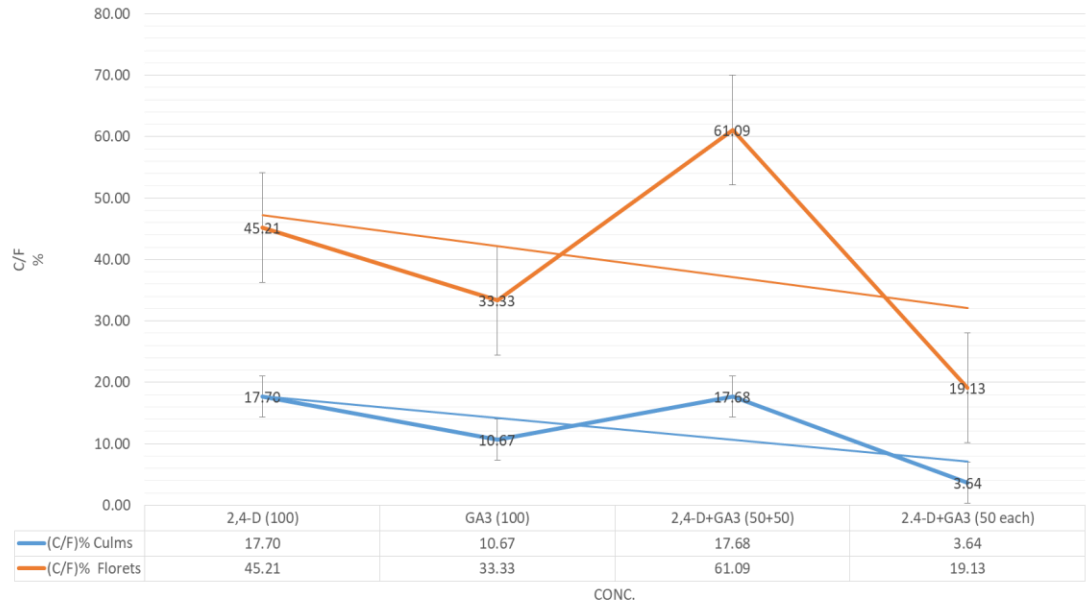

Figure 3: Comparison of florets obtained by floret and culm application of phytohormone