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Induction of seed dormancy by foliar spray of growth inhibitors in rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted during *Kharif* season, 2017-2018 at the experimental field of Department of Crop Physiology, ANDUA&T, Ayodhya to study the effect of foliar spray of growth inhibitors by different concentration *viz*. Maleic Hydrazide (500ppm and 1000ppm) and Cycocel (500ppm and 1000ppm) along with untreated control to induce dormancy in rice (*Oryza sativa* L.). The experiment was laid out in randomized block design comprising nine treatments at two stages (*viz*. flowering stage and anthesis stage) in three replications. Observations had been studied *in vivo* on germination percentage, viability test and biochemical parameters *viz*. chlorophyll, starch, protein and α-amylase activity. Among all the concentrations, maximum chlorophyll content was recorded in MH@1000ppm was followed by cycocel@500ppm before anthesis stage, maximum protein and starch content was found in cycocel@500ppm before flowering stage but maximum inhibition of germination percentage and α-amylase activity was observed with cycocel@1000ppm before anthesis stage but cycocel @ 500ppm was found most appropriate before anthesis stage which was very much effective for safe induction of seed dormancy in rice because of its minimum viability loss. Loss in viability may be due to some toxic effect caused by high concentration of cycocel.

Keywords: Cycocel, foliar spray, induction, maleic hydrazide, rice, seed dormancy, viability

Introduction
Rice (*Oryza sativa* L., 2n= 24), belongs to the family Poaceae (Graminae). It is the most important food crop of the developing world and is the staple food of more than half of the world's population. Rice contributes 43% of total food grain production and 46% of the total cereal production of the country. According to United States Department of Agriculture (USDA) rice production in 2017-2018 is 112.9mt. India stands on rank 1st with respect of area (45.35 ha.) and 2nd in production (112.9 Mt.).

Seed quality has multiple concepts having several components such as genetic purity, Physical Purity, insect-pest, weeds, germination, moisture content, vigour and uniformity. The quality seed is the main and principle mean to secure crop yield in less favorable areas, and this is the main vehicle for rehabilitation in agriculture. The inability of newly harvested seeds to continue their development under favourable environmental conditions like moisture, temperature, oxygen supply is generally known as Dormancy. It is the natural phenomenon in the plant kingdom. It allows plant to survive under unfavorable environmental conditions. It is generally assumed that dormancy is mainly of two types *i.e.* Primary and Secondary types. The dormancy due to embryo factors or due to seed coat is called as Primary dormancy. The state of dormancy in seed may also be induced due to secondary factors like light, temperature etc. is called as secondary dormancy. Dormancy is a mechanism by which seeds maintain their viability in unfavorable conditions. The characteristics of dormancy may be considered as beneficial in short duration varieties because the crop attains the maturity stage in rainy season itself at that time the proper threshing may not be possible. On the other side it possess cereal problem in testing giving misleading result and require induction of dormancy. Post harvest sprouting is nowadays became a serious problem which adversely affect the quality of seeds and make farmers suffer from great loss. There are many chemicals and plant hormones by which dormancy can be induced.

Materials and Methods
The experiment was carried out under normal field conditions in Kharif season during 2018-19 at crop physiology field of Acharya Narendra deva university of agriculture and technology,

Narendra nagar, Kumarganj, Ayodhya (U.P). Seeds of sambha mahsuri were brought from Nagipur seed research farm, ANDUAT Kumarganj, Ayodhya and nursery was raised. Thirty days old seedling was transplanted to the properly ploughed and lavelled field of Crop Physiology department. Three seedlings were used for transplanting and the experimental design was RBD (Randomised Block Design). Nine treatments were allocated with three replications. All the package of practices was followed as per the general agronomic practices for rice crop. Solutions of M.H @500ppm, 1000ppm and cycocel @500ppm and 1000ppm were prepared by weight by volume (w/v) and volume by volume (v/v) basis and sprayed before flowering and anthesis stage and the estimation was done at flowering, anthesis and maturity stage for chlorophyll, starch and protein content. Chlorophyll content of leaf was directly measured in intact leaves with the help of SPAD meter. Third leaf from the top was taken for this purpose. Starch content in the plant material was estimated by using the method of *Mc. Cready et al.* (1958). Total protein content of the plant sample was estimated by the method given by *Lowery et al.* (1951). The main objective of this experiment was to induce safe dormancy in the rice seeds and dormancy can only be examined by conducting germination test immediately after harvest. Seed germination test was done in the laboratory as per ISTA procedure by adopting the rolled paper towel method at 25 ^{0}C temperature and 90±5 percent relative humidity in seed germinator. The number of germinated seeds was counted and the germination percentage was calculated as per the formula given below:

$$\text{Germination (\%)} = \frac{\text{No.of normal seedlings}}{\text{Total number of seeds}} \times 100$$

Viability test (Tz test) was determined immediately after harvest by tetrazolium test as described by *Lakon* (1949) and the seeds were evaluated as viable or dead on the basis of staining pattern in embryo. The α amylase activity in embryo axis and endosperm after 48, 72 and 96hrs of germination was assayed according to the method of *Bernfeld* (1953).

Result and Discussion

Leaf chlorophyll content at anthesis and maturity stage showed significant effect and maximum chlorophyll content. At anthesis stage maximum chlorophyll was noticed with MH@1000ppm (before flowering stage) followed by cycocel @500ppm (before anthesis stage). Significantly higher chlorophyll content was observed with foliar spray of MH @1000ppm (before flowering stage) followed by cycocel @500ppm (before anthesis stage). When compared with control all the treatments showed increase in leaf chlorophyll content. The increase in chlorophyll content may be due to the result of chlorophylase enzyme, which is responsible for chlorophyll degradation and inhibition and this chlorophylase enzyme may be inhibited by the cycocel application. Hofner (1977) [2] reported that chlorophyll content in leaves was increased with cycocel application in sunflower, Santosh kumari (2017) [7] with cycocel, Singh *et al.* (1987) [8] with cycocel @300ppm in soyabean, Sorte *et al.* (1989) [9] with cycocel in groundnut, Chetti *et al.* (1991) [1] with cycocel in groundnut also reported the similar finding**.** Growth inhibitors mainly prevent leaves expansion, making leaves thicker and greener which might be the reason for higher chlorophyll content in treated plants.

Significantly maximum increase in protein and starch content was observed with cycocel @500ppm (before flowering stage) at anthesis, maturity stage and also in grains. The increase in protein content may be attributed with increased in structural component of RNA molecules of amino acids and also marked increase in DNA, RNA and protein synthesis in ribosomes which is the site of protein synthesis in plants. The increase in protein content was found by Kumari *et al.* (1990) [4] with cycocel application @0.8% in sunflower crop.

Data pertaining seed viability and germination (%) clearly indicated that foliar application of maleic hydrazide @500ppm and 1000ppm before flowering suppressed the seed germination by 74% and 80% accompanied with higher seed viability *i.e.* 96.00%. Similarly foliar application of high concentration of maleic hydrazide and cycocel at anthesis stage showed more significant effect to induce dormancy. Mean while foliar application of cycocel and maleic hydrazide at anthesis showed inhibition of germination to 83% and 82% but also cause more detrimental effect to seed viability *i.e.* loss of seed viability. Loss of seed viability might be due to higher concentration of maleic hydrazide and cycocel which cause some toxic effect that hamper the viability of the seeds (93.00%). So, it can be easy concluded that cycocel @500ppm is best for dormancy induction and appropriate stage is anthesis stage for the safe induction of seed dormancy in rice. Next to this, cycocel @1000ppm showed maximum inhibition in α amylase activity but cycocel @500ppm causes at par inhibition in α amylase activity.. Concentration of Cycocel@ 500ppm caused maximum viability, more germination inhibition and more inhibition in alpha amylase activity. It can be easy concluded that cycocel @500ppm is best for dormancy induction and appropriate stage is anthesis stage for the safe induction of seed dormancy in rice. This finding is supported by Nagarjun and Radder (1983) [5] with MH at 75 and 90DAS, Randhawa and Nandpuri (1966) [6] with MH @1000ppm in onion bulbs, Jayadeva, (2008) with MH @100ppm in groundnut

Table 1: Effect of foliar application of growth inhibitors (M.H and Cycocel) on chlorophyll content of rice plant (*Oryza sativa* L.)

Treatments	At flowering	At anthesis	At maturity
T1: Control	7.20	6.38	6.10
T2: Foliar spray of MH @500ppm before flowering	7.39	6.85	6.16
T3: Foliar spray of MH @1000ppm before flowering	8.45	7.93	7.53
T4: Foliar spray of Cycocel @500ppm before flowering	8.32	6.89	6.24
T5: Foliar spray of Cycocel @1000ppm before flowering	7.35	6.50	6.18
T6: Foliar spray of MH @500ppm before anthesis	8.33	6.87	6.41
T7: Foliar spray of MH @1000ppm before anthesis	7.36	6.86	6.47
T8: Foliar spray of cycocel @500ppm before anthesis	8.25	7.39	6.24
T9: Foliar spray of Cycocel @1000ppm before anthesis	8.34	7.02	6.58
Grand mean	7.89	6.97	6.43
SEm±	NS	0.15	0.15
CD at 5%	NS	0.46	0.44

Table 2: Effect of foliar application of growth inhibitors (M.H and Cycocel) on protein content (mg/g fresh wt.) of rice (*Oryza sativa* L.)

Treatments	At flowering	At anthesis	At maturity	In grains
T1: Control	26.90	33.76	28.45	0.325
T2: Foliar spray of MH@500ppm before flowering	27.52	34.82	32.14	0.362
T3: Foliar spray of MH@1000ppm before flowering	27.83	34.91	31.52	0.363
T4: Foliar spray of Cycocel @500ppm before flowering	30.46	37.69	33.23	0.465
T5: Foliar spray of Cycocel @1000ppm before flowering	27.50	33.85	29.41	0.368
T6: Foliar spray of MH@500ppm before anthesis	27.42	34.51	30.45	0.442
T7: Foliar spray of MH@1000ppm before anthesis	27.84	34.69	30.12	0.448
T8: Foliar spray of cycocel @500ppm before anthesis	27.12	34.08	30.18	0.331
T9: Foliar spray of Cycocel @1000ppm before anthesis	27.24	35.36	32.64	0.331
Grand Mean	27.76	34.85	30.90	0.380
SEm±	NS	0.40	0.53	0.02
CD at 5%	NS	1.19	1.58	0.06

Table 3: Effect of foliar application of growth inhibitors (M.H and Cycocel) on starch content (mg/g dry weight) of rice (*Oryza sativa* L.)

Treatments	At flowering	At anthesis	At maturity	In grains
T1: Control	208.25	242.25	119.50	6.75
T2: Foliar spray of MH@500ppm before flowering	225.75	248.25	127.25	7.00
T3: Foliar spray of MH@1000ppm before flowering	217.00	258.50	142.75	7.25
T4: Foliar spray of Cycocel @500ppm before flowering	234.25	263.50	143.25	8.52
T5: Foliar spray of Cycocel @1000ppm before flowering	229.50	258.75	131.75	7.50
T6: Foliar spray of MH@500ppm before anthesis	228.75	251.25	139.00	7.75
T7: Foliar spray of MH@1000ppm before anthesis	223.75	261.25	128.50	8.25
T8: Foliar spray of cycocel @500ppm before anthesis	225.50	251.75	132.25	7.25
T9: Foliar spray of Cycocel @1000ppm before anthesis	226.25	253.25	139.75	7.35
Grand Mean	224.33	254.31	133.78	7.51
SEm±	NS	2.26	2.67	0.19
CD at 5%	NS	6.79	8.01	0.57

Table 4: Effect of foliar application of growth inhibitors (M.H and Cycocel) on α amylase activity (mg/g fresh weight) in germinating rice seed (*Oryza sativa* L.)

Treatments	At 48hrs	At 72hrs	At 96hrs
T1: Control	616.00	1032.00	1482.00
T2: Foliar spray of MH@500ppm before flowering	384.00	880.00	893.00
T3: Foliar spray of MH@1000ppm before flowering	358.00	838.00	968.00
T4: Foliar spray of Cycocel @500ppm before flowering	336.00	842.00	918.00
T5: Foliar spray of Cycocel @1000ppm before flowering	484.00	984.00	998.00
T6: Foliar spray of MH@500ppm before anthesis	476.00	890.00	904.00
T7: Foliar spray of MH@1000ppm before anthesis	458.00	972.00	986.00
T8: Foliar spray of cycocel @500ppm before anthesis	436.00	876.00	985.00
T9: Foliar spray of Cycocel @1000ppm before anthesis	324.00	832.00	858.00
Grand Mean	430.22	905.11	999.11
SEm±	30.69	24.25	62.51
CD at 5%	92.01	72.70	187.40

Table 5: Effect of foliar application of growth inhibitors (M.H and Cycocel) on seed viability and germination percent of rice (*Oryza sativa* L.)

Treatments	Seed viability (%)	Germination (%)
T1: Control	96.00	95.00
T2: Foliar spray of MH@500ppm before flowering	96.00	26.00
T3: Foliar spray of MH@1000ppm before flowering	96.00	20.00
T4: Foliar spray of Cycocel @500ppm before flowering	93.00	32.00
T5: Foliar spray of Cycocel @1000ppm before flowering	93.00	29.00
T6: Foliar spray of MH@500ppm before anthesis	96.00	27.00
T7: Foliar spray of MH@1000ppm before anthesis	94.00	18.00
T8: Foliar spray of cycocel @500ppm before anthesis	96.00	18.00
T9: Foliar spray of Cycocel @1000ppm before anthesis	93.00	17.00
Grand Mean	94.77	38.16
SEm±	0.59	2.44
CD at 5%	1.75	7.33

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