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DORMANCY BEHAVIOUR OF DEVELOPING SEEDS IN DIFFERENT GENOTYPES OF CHILLI (*Capsicum Annuum* L.)

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Abstract: Dormancy prevalent in developing seeds was studied in five diverse genotypes of Chilli in central farm, Odisha University of Agriculture and Technology, Bhubaneswar in 2014 in Randomized block design (RBD). Developing seeds at six developmental stages harvested in every seven days interval starting from 28 DAA were screened for existing dormancy by assessing germination percentage and vigour index in control and two dormancy breaking treatments (KNO_3 0.2% and GA_3 treatment 0.3%). Results revealed that germination was initiated in 3 genotypes at 35 DAA in both control and treatment and at 28 DAA in two genotypes. Dormancy at the middle stage of maturity (35-42 DAA) responded more (90%) to treatment which gradually reduced up to 49 DAA. Average response to dormancy breaking treatments was <20% in all stages. Significant difference was observed with respect to all parameters in both control and treatment indicating differential genotype specific dormancy behaviour.

Keywords: Chilli (*Capsicum annuum*L.), Seed development, Dormancy, Germination percentage, Vigour index.

Introduction

Chilli (*Capsicum annum* L.; 2N=24) is an important spicy vegetable of the Solanaceae family extensively cultivated in India. It is a native of new world tropic which was brought in to India from Brazil by Portuguese prior to 1785. Within the genus Capsicum, *Capsicum annum, Capsicum baccatum, Capsicum Chinese, Capsicum frutescens* and *Capsicum pubescens* are commonly cultivated and are recognized by International Bureau of Plant Genetic Resources (Bosland and Votava, 2000; Wang and Bosland, 2006) while approximately 25 wild species have been documented. Among them *Capsicum annum* is extensively cultivated and has diverse uses as spice, condiment, culinary supplement, medicine, vegetable due to its pungency, taste, appealing colour and flavor. Capsicum species exhibit rich genetic diversity. Hence collection and characterization of chilli genotypes have specific research interest. Acquisition of germplasm needs collection of fruits at different

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developmental stages necessitating germination of seeds at varying maturity stage. However in developing chilli seeds, dormancy is exhibited to different extent creating hindrance in germination, though the seed had attained necessary physiological growth to support germination. Initiation of germination starts long before the seeds attain physiological maturity (Radhe-Shyam *et al.* 1996). Presence of inhibitory hormones in the early and middle phases of development hinders germination to full potential which gradually reduces and towards the late stages the effect of dormancy literally fades out which may be an interaction of reduction in seed moisture content, reduction in ABA and embryo maturity. In Chilli, Post-harvest ripening helps in embryo maturity and improves germination. This phenomenon is highly dependent on the genetic makeup of the cultivars, so, cultivar divergence in dormancy behaviour is inevitable. Chilli fruits take relatively longer period to mature (nearly 50-60 days) and seeds attain physiological maturity nearly at 45-55 days after anthesis, which is the best time for harvesting. (Reddy *et al.* 2001) Retention of fruits in the plant after physiological maturity for field maturity results in fruit drop, fungal attack which is responsible for reducing seed quality both in terms of physiological quality and appearance. Keeping these propositions in mind, the present experiment was designed to study the dormancy behaviour of the chilli seeds at different developmental stages.

Materials and methods

Three local landraces of chilli (Dhanua Black, Bullet & Kagaon local) along with two released varieties from OUAT, Bhubaneswar (Utkal Rashmi & Utkal Abha) were used in the experiment for understanding the dormancy behavior of developing chilli seeds and grown in central Research Station of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha during Rabi 2013-14. For assessing dormancy behavior of developing seeds, sufficient numbers of flowers were tagged on a particular blooming date of all the genotypes. Developing fruits were harvested on each of six different stages starting from 28 days after anthesis (DAA) and at 7 days interval thereafter till 63 DAA. At each stage, 10 fruits from each of three replications for all the genotypes were sampled. Developing seeds at different developmental stages were screened for existing dormancy by assessing germination percentage, vigour index by use of dormancy breaking chemicals like 0.2% Potassium Nitrate (KNO_3) and 0.3% Gibberellic Acid (GA_3). All these parameters were compared with a control and analyzed with randomized block design (RBD) using ANOVA.

Results and discussion

The seed quality parameters like germination, vigour were tested for the seeds before storing and found to be above the standard in all the varieties.

Germination Percentage (%)

From Table 1, it is revealed that, in variety Utkal Rashmi, mean germination percentage was maximum in GA_3 treated seeds (39.38%) followed by KNO_3 treatment (37.54%) and control (34.63%).

Table 1: Germination (%) of Chilli (Var. Utkal Rashmi) seeds at different maturity stages with different treatments

Treatment	Germination (%) at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	0	3.50	7.25	16.25	84.00	96.75	34.63
KNO_3	0	7.75	10.25	24.25	85.00	98.00	37.54
GA_3	0	6.50	15.25	28.75	85.75	100.00	39.38
Mean		5.92	10.92	23.08	84.92	98.25	
SEM (±)		2.72	4.89	3.33	2.58	1.09	
C.D(5%)		6.66	11.96	8.16	6.30	2.67	
C.D(1%)		10.10	18.12	12.36	9.55	4.05	

Observing the mean germination over the developmental period highest in 63 DAA (98.25%) followed by 56 DAA (84.92%). However, the average germination was quite low at 49 DAA (23.08%), which was increased by 2.7 times by 56 DAA (84.92%). The germination was enhanced by 50% with dormancy breaking treatments at 49 DAA (23.08%) which was similar to 35 DAA (5.92%) and 42 DAA (10.92%). No seed dormancy was noticed after 49 DAA. So variety Utkal Rashmi exhibited very less dormancy over the developmental stages which was nil after 49 DAA.

In variety Utkal Abha, Mean germination was maximum in GA_3 treated seeds (49%) followed by KNO_3 treatment (46.63%) and control (27.38%). The mean germination observed over the developmental period (Days After Anthesis), maximum germination was noted at 63 DAA (80.17%) followed by 56 DAA (60.50%). The dormancy was gradually decreased over the period of Days after Anthesis. But after 49 DAA (48.67%) the dormancy was reported to be nearly constant. However percentage Germination was continued to

increase after 49 DAA in response to both dormancy breaking treatments. So variety Utkal Abha exhibited higher degree of dormancy which persisted over the developmental stages even after field maturity.

Table 2: Germination (%) of Chilli (Var. Utkal Abha) seeds at different maturity stages with different treatments

Treatment	Germination (%) at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	4.75	10.75	16.75	35.50	47.75	48.75	27.38
KNO_3	17.75	19.25	23.50	50.75	71.75	96.75	46.63
GA_3	17.50	22.50	25.25	59.75	74.00	95.00	49.00
Mean	13.33	17.50	21.83	48.67	64.50	80.17	
S.E.	1.52	4.26	4.46	6.56	5.49	4.84	
C.D 5%	3.72	10.42	10.92	16.04	13.45	11.84	
C.D 1%	5.63	15.79	16.54	24.30	20.37	17.94	

In variety Dhanua Black the mean germination percentage was at par in GA_3 (43.38%) and KNO_3 treated seeds (43.25%). A very meager difference occurred and GA_3 treated seeds showed maximum germination. It showed very less germination till 42 DAA (17.75%) in control. However mean germination over treatments increased very rapidly till 49 DAA (48.67%) with dormancy breaking treatments. After 56 DAA, mean germination was increased over maturity (55.67%) which continued till 63 DAA. In this genotype sufficient amount of dormancy was noted for all developmental stages and improvement of germination was more than 100% to 50% over the period of maturity in response to dormancy breaking chemicals. So in genotype Dhanua Black dormancy played an important role in deciding seed germination.

Table 3: Germination (%) of Chilli (Var. Dhanua Black) seeds at different maturity stages with different treatments

Treatment	Germination (%) at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	0	4.50	6.50	22.50	25.25	61.75	20.08
KNO_3	0	11.00	25.00	60.25	67.75	95.50	43.25
GA_3	0	8.50	21.75	63.25	74.00	92.75	43.38

Mean	8.00	17.75	48.67	55.67	83.33
S.E.	1.63	3.64	6.98	2.14	2.23
C.D 5%	4.00	8.91	17.09	5.24	5.46
C.D 1%	6.05	13.49	25.88	7.94	8.27

In genotype Bullet, mean germination percentage was maximum in GA3 treated seeds (72.25%) followed by KNO_3 treatment (71.58%) and control (55.85%). Mean germination over Days After Anthesis was maximum at 63 DAA (99.92%) followed by 56 DAA (95.17%) and 49 DAA (87.08%). Average germination was quite low at 35 DAA (31.75%) which was increased by 1.3 times at 42 DAA (73.83%). The germination percentage was enhanced in dormancy breaking chemicals till 49 DAA. Dormancy was not seen after 49 DAA. So variety Bullet exhibited very less dormancy towards the late developmental stages which was nil after 49 DAA.

Table 4: Germination (%) of Chilli (Genotype Bullet) seeds at different maturity stages with different treatments

Treatment	Germination (%) at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	5.59	6.75	52.50	76.00	94.50	99.75	55.85
KNO_3	15.75	42.75	84.00	92.00	95.00	100.00	71.58
GA_3	13.50	45.75	85.00	93.25	96.00	100.00	72.25
Mean	11.61	31.75	73.83	87.08	95.17	99.92	
S.E.	1.48	5.15	3.82	1.94	1.53	0.29	
C.D 5%	3.62	12.61	9.34	4.74	3.74	0.71	
C.D 1%	5.49	19.10	14.14	7.18	5.66	1.07	

In genotype Kagaon, the mean germination percentage was maximum in GA_3 treated seed (43.21%) followed by KNO_3 treatment (41.58%) and control (35.58%). Mean germination percentage over the Days After Anthesis was maximum at 63 DAA (96.25%) followed by 56 DAA (91.92%). However mean germination percentage was very low in 49 DAA (32.33%) and increased more than 200% at 56 DAA (91.92%). The germination percentage was not enhanced more with treatments of dormancy breaking chemicals. Dormancy was not seen

from 56 DAA. So variety Kagaon exhibited more dormancy throughout the developmental period and was nil from 56 DAA.

Table 5: Germination (%) of Chilli (Genotype Kagaon) seeds at different maturity stages with different treatments

Treatment	Germination (%) at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	0	0.50	8.25	18.25	92.25	94.25	35.58
KNO_3	0	5.50	15.00	37.50	93.25	98.25	41.58
GA_3	0	7.00	24.50	41.25	90.25	96.25	43.21
Mean		4.33	15.92	32.33	91.92	96.25	
S.E.		2.00	2.41	5.29	2.36	0.82	
C.D 5%		4.89	5.90	12.94	5.77	2.00	
C.D 1%		7.41	8.93	19.61	8.74	3.03	

Seed mass maturity may occur about 50 days after anthesis, with 10-12 more days required for maximum potential longevity but 17-21 days for maximal seedling dry weight (based on variation in time from sowing to emergence) (Demir and Ellis, 1992). Freshly harvested seeds of certain wild Capsicum species can exhibit dormancy (Bosland and Votava, 2000; Wien, 1997; IBPGR, 1983). In the present experiment results revealed that germination was initiated in 3 genotypes at 35 DAA in both control and with dormancy breaking treatment and at 28 DAA in other two genotypes. However Utkal Abha and Dhanua Black exhibited substantial dormancy even after (63 DAA) else physiological maturity and germination % was 48.75% and 61.75% respectively. Further it was enhanced to more than 90% with use of chemicals in V_4 (Bullet) dormancy was more prominent at the middle stage of maturity (35-42 DAA) which gradually reduced towards the physiological maturity stage. In V_5 (Kagaon) dormancy was noticed at between (42-49 DAA) which responded fairly to dormancy breaking treatment. But in V_1 (Utkal Rashmi) the germination was increased in a uniform manner with less visible dormancy. Dormancy breaking treatments helped to increase germination to some extent (i.e. < 20%) in all stages. After 49 DAA no dormancy was there. So significant difference was observed with respect to germination percentage and vigour index with and without use of dormancy breaking treatments indicating differential dormancy

behaviour which is the inherent character of each genotype. The results corroborates with the findings of Randle & Homna (1981).

Vigour Index

In variety Utkal Rashmi, mean vigour index was maximum for KNO_3 treatment (262) followed by GA_3 treatment (239) and control (142). At 63 DAA the mean vigour index was maximum (640) followed by 56 DAA (317) and 49 DAA (77). Vigour index has increased more than 600 % at 35 DAA for both KNO3 and GA_3 treatment indicating presence of sufficient dormancy. GA_3 treatment was significantly better for increasing vigour index of seeds on 42 DAA (47), 49 DAA (109) and 56 DAA (373) compared to KNO_3 treatment (27 at 42 DAA, 81 at 49 DAA, 340 at 56 DAA). But at 63 DAA, KNO_3 was best of all 3 treatments and vigour index was more than 200% than control. So Utkal Rashmi has exhibited dormancy over all developmental stages which was more prominent in early developmental stages and diminished with advancement of seed development which was persistent throughout the period.

Table 6: Vigour Index of Chilli (Var. Utkal Rashmi) seeds at different maturity stages with different treatments

Treatment	Vigour Index at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control		3	10	40	239	416	142
KNO_3		11	27	81	340	853	262
GA_3		15	47	109	373	650	239
Mean		10	28	77	317	640	

In variety Utkal Abha, mean vigour index was maximum for KNO_3 treatment (186) followed by GA_3 treatment (185) and control (51). At 63 DAA the mean vigour index was maximum (359) followed by 56 DAA (246) and 49 DAA (153). Vigour index was still nil at 35 DAA for both KNO_3 and GA_3 treatment indicating presence of sufficient dormancy.

Table 7: Vigour Index of Chilli (Var. Utkal Abha) seeds at different maturity stages with different treatments

Treatment	Vigour Index at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	6	16	27	80	117	141	65
KNO_3	24	48	66	192	300	484	186
GA_3	32	68	52	186	320	454	185
Mean	21	44	48	153	246	359	

GA_3 treatment was significantly better for increasing vigour index of seeds on 56 DAA (320) compared to KNO_3 treatment (66 at 42 DAA, 192 at 49 DAA, 484 at 63 DAA). So Utkal Abha has exhibited dormancy over all developmental stages which was more prominent in early developmental stages and diminished with advancement of seed development (Table 7). In genotype Dhanua Black, mean vigour index was maximum for GA_3 treatment (472) followed by KNO_3 treatment (450) and control (114). At 63 DAA the mean vigour index was maximum (850) followed by 56 DAA (473) and 49 DAA (311). Vigour index was still nil at 35 DAA for both KNO_3 and GA_3treatment indicating presence of sufficient dormancy. GA_3 treatment was significantly better for increasing vigour index of seeds on 49 DAA (438), 56 DAA (677) and 63 DAA (1118) compared to KNO_3 treatment (117 at 42 DAA). So Dhanua Black has exhibited dormancy over all developmental stages which was more prominent in early developmental stages and diminished with advancement of seed development (Table 8).

Table 8: Vigour Index of Chilli (Var. Dhanua Black) seeds at different maturity stages with different treatments

Treatment	Vigour Index at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control		4	15	93	122	338	114
KNO_3		17	117	402	618	1096	450
GA_3		14	114	438	677	1118	472
Mean		12	82	311	473	850	

In genotype Bullet, mean vigour index was maximum for GA_3 treatment (475) followed by KNO_3 treatment (467) and control (233). At 63 DAA the mean vigour index was maximum (914) followed by 56 DAA (629) and 49 DAA (464). GA_3 treatment was significantly better for increasing vigour index of seeds on 35 DAA (109), 42 DAA (391), 49 DAA (578) and 56 DAA (746) compared to KNO_3 treatment (1113 at 63 DAA). So Bullet has exhibited dormancy over all developmental stages which was more prominent in early developmental stages and diminished with advancement of seed development (Table 9).

Table 9: Vigour Index of Chilli (Var. Bullet) seeds at different maturity stages with different treatments

Treatment	Vigour Index at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control	6	12	101	283	406	606	233
KNO_3	25	112	332	531	734	1113	467
GA_3	23	121	391	578	746	1023	475
Mean	18	82	274	464	629	98.25	

In genotype Kagaon, mean vigour index was maximum for GA_3 treatment (275) followed by KNO_3 treatment (263) and control (135). At 63 DAA the mean vigour index was maximum (518) followed by 56 DAA (450) and 49 DAA (118). Vigour index was nil still 35 DAA for both KNO_3 and GA_3 treatment indicating presence of sufficient dormancy in first stage of seed development. GA_3 treatment was significantly better for increasing vigour index of seeds on 42 DAA (43) and49 DAA (190) compared to KNO_3 treatment (532 at 56 and 614 at 63 DAA). So Kagaon has exhibited dormancy over all developmental stages which was more prominent in early developmental stages and diminished with advancement of seed development (Table 10).

Table 10: Vigour Index of Chilli (Var. Kagaon) seeds at different maturity stages with different treatments

Treatment	Vigour Index at different Days After Anthesis						Mean
	28 DAA	35 DAA	42 DAA	49 DAA	56 DAA	63 DAA	
Control		1	6	35	300	332	135
KNO_3		9	35	128	532	614	263
GA_3		13	43	190	519	609	275
Mean		8	28	118	450	518	

Conclusion

The germination was increased in a uniform manner with less visible dormancy. Dormancy breaking treatments helped to increase germination to some extent (i. e < 20%) in all stages. After 49 DAA no dormancy was there. So significant difference was observed with respect to germination percentage and vigour index with and without use of dormancy breaking

treatments indicating differential dormancy behavior which is the inherent character of each genotype.

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