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FULL PAPER

Seed germination analysis in germplasm of *Capsicum annum*

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Graphical abstract

Abstract

Capsicum annum is commercially cultivated due to its nutritional and pharmaceutical values. It is particularly important in Malaysia due to its abundant use in daily life food. Although it is warm seasonal plant, its productivity is not high in tropical environment. High seed germination is the prerequisite for good seedling establishment. Present study is conducted to study the varietal response for germination traits in diverse capsicum germplasm. Five germination traits were focused e.g. Final germination percentage (FGP), speed of germination (SG), initiation of germination (IG), days to 50% germination (R50) and peak period of germination (GP). Seeds of each variety were kept in triplicate at room temperature using Yoshida medium coupled with photoperiod of 14 hours for two weeks. Mean values for FGP (81%), SG (rate=2), IG (9th day) and R50 (10th day) and GP (12th day) were observed in 93 varieties. Analysis of variance (ANOVA) showed significant difference for all germination traits, reflecting that present germplasm is diverse for germination traits. These findings would be useful to improve the germination traits in capsicum hybridization programs.

***Keywords*:** Capsicum annum, germination, germplasm, germination traits

INTRODUCTION

Capsicum annum is a spicy-fruity vegetable cultivated worldwide as an important vegetable [1]. India recorded as highest consumer rate for *capsicum* which approximately 36% of the world production followed by China about 11% of overall *capsicum* production.Among 31 species, 5 are domesticated including *C.annuum* L., *C.chinense Jacq*., C.*frutescens* L, C.*baccatum* L. and C.*pubescens* [2]. The first three species are most cultivated which forms "annum-chinense-frutescens" complex due to similarity in their genetic pool composition and morphological traits [3]. Until today, *capsicums* were utilized universally as spice in three forms: fresh, dried, powder [4]. Apart from spice, enriched with essential proteins, lipids, carbohydrates, fibres, mineral salts (Ca,P,Fe) and fat soluble vitamins.

It is also a good source of ascorbic acid (Vitamin A), carotenoids (Vitamin A), tocopherols (Vitamin E) and importantly, capsaicinoids (alkaloid compound) which responsible for alleviating chronic diseases such as tumors, coughs, sore throats and heart related diseases [5].It is also believed that, fresh capsicums helps in proper digestion of starchy foods and trigger immunity in human body [6]. Pharmaceutically, they are used as immunosuppressive agent to inhibit the growth of non-essential bacteria.

Globally, *capsicum* is the only vegetable that creates huge revenue for farmers which played significant role in human welfare and also overcome scarcity of food [7]. Even though capsicum needed for economic and medicinal purposes, it seems to be an 'ignored' crop due to lack of attention in terms of agricultural development. With traditional farming method, farmers often faced many biotic (pests and diseases) and abiotic (drought, salinity, heavy metal toxicities and poor soil texture) stresses that resulted in reduced production of yield [8]. One of the major problem is germination pattern. Since the propagation of this crop is by seed, it is very important to evaluate the seed quality to establish uniform growth and successful yield collection. Under normal laboratory conditions, seed germination is characterized by activation of biological process due to influx of water into the seed coat that caused the projection of radicle from the embryonic alignment [9]. Tropical environment like Malaysia and Thailand provides suitable climate for producing and cultivation of good capsicum seeds, adding seed quality is precious for commercialization [10]. Previous studies have highlighted that germination process in *Capsicum annum* influenced by several factors including high seed moisture, high seed temperature, seedlings from old seeds that could contributegreat loss of seed viability, quality and yield of crop [11]-[12].Uniform germination and healthy seedling development are key factor for higher output in vegetable crops.

Germination percentage is most crucial parameter for seed cultivation. Speed of germination is another indicator to measure the vigority of seed in a seed lot. Seed that grows rapidly and vigorously in normal conditions are responsible for increased capability to produce healthy seedling in field situations. The time frame for maximum number of seedlings is known as period of germination [13]. On the other hand, initiation of germination and days to 50% germination are used to estimate the number of seedlings attained before complete germination process. Even though number of literatures has been reported, information on capsicum seed germination is still lacking. Therefore, we present in this article the

findings on analysis of seed germination traits in *Capsicum annuum* germplasm.

EXPERIMENTS

Collection of seeds

93 varieties of Capsicum annum seeds were purchased and collected from Pepperseeds (Netherlands) and Fatalii (Finland). Seeds were then stored at temperature of 20°C to prevent seed deterioration and loss of viability.

Germination experiment

Germination was carried out during end January until mid of February 2015(2-3 months after seed collection). Screening of seeds was carried by soaking in distilled water for 24 hours to ensure viability of seeds. Three replicates of 10 seeds were used for each accession studied. 10mL of Yoshida solution was added into petri dish and the filter paper were moistened frequently to ensure continuous saturation during the germination period. Upon wetting, the petri dish was sealed tightly with Parafilm and place in growth room at 28±0.5°C.The germinating seeds were counted daily for first 5 days and after that, every 2 days until the end of experiment. The seed was considered germinated when the radicle emergence about 2mm in length.

Method of germination traits

The seed germination parameters were final germination percentage (FGP), speed of germination (SG), initiation of germination (IG), days to 50% germination (T50) and peak period of germination (GP) were demonstrated and expressed using the method recommended by[14];

i. $FGP = \frac{Total number\ of\ germinated\ seeds}{Total\ number\ of\ seeds} \times 100$

ii. $SG = \frac{Number\ of\ germinated\ seeds}{Day\ of\ first\ count} + \ldots + \frac{Number\ of\ germinated\ seeds}{Day\ on\ final\ count}$

iii. IG = Day on which the first germination event occurred

iv. T50 = $t_i + [(N/2 - n_i) (t_i - t_j)] / n_i - n_j$, where N is final number of emergence, n_i and n_j are cumulative number of seeds germinated by adjacent counts at times t_i and t_j respectively when $n_i < N / 2 < n_j$.

v. GP = Days from sowing to maximum number of seed germinated

The experiments were repeated twice which showed similar trend.

Statistical analysis

At the end of experiment, the data were subjected to one way analysis of variance (ANOVA) to test the different varieties on germination traits by using SPSS, version 16.

RESULTS AND DISCUSSION

From the experiment, maximum and minimum germination percentage was achieved at 96% and 34% respectively. While mean germination percentage recorded about 81% (Table 2). This agrees with the findings of [13] in Kalmegh seeds and maize seeds [15]. It further explained that controlled condition achieved highest seed germination compared to non-controlled condition [16]. Seeds with greater germination percentage reflected healthy endosperm with enhanced ability to absorb nutrients and water as reported in soya bean conducted by [17]. Higher seed germination give rise to healthy seedlings which later contribute to increase in yield of production [11]. However, minimal germination percentage could be caused by physical disturbances such as mechanical forces or metabolic disorders that lead to poor seed development [18]. Since the feature of seed coat is soft, such physical disturbance may exert high impact on the embryo. Analysis of variance showed that there is significant differences between genotypes and all tested germination traits ($P<0.05$) (Table 1). According to [20], vigority of seed is measured by speed of germination (SG). In this experiment, recorded average speed was only 2 contradicting with the findings by [21] who studied germination on *Corchorus olitorius*, *Celosia argentea*, *Amaranthus cruentus*, *Abelmoschus esculentus* and *Delonix regia* seeds. Although estimation of seedling yield relies on capability of seed in particular seed lot, nevertheless it is independent to speed of germination. Pearson's correlation confirms that both FGP and SG are negatively correlated showing maximum germination percentage achieved with low speed by prolong the germination days.

Given lowest speed germination, initiation day of germination (IG) and days to 50 percent of germination (T50) were achieved on 9th and 10th days respectively. That means it supports the earlier deductions that most seeds have late germination. Interestingly, the time gap between IG and T50 was only one day. These ideas partially match with previous findings on *Capsicum annuum* 'Solan Bharpur' [22]. The differences could be due to different genetic content that make the whole performance of the seed germination. T50 can be divided into three distinct groups: slow (day 11), average (day 9 or 10) and fast (day 8). In this case, it belongs to average germinating family correspond to [23]. It has been reported that T50 are greatly dominated by genetic control [24].

The fastest and slowest germination families in this study differed by an average of 9 days in time to 50% germination of viable seeds representing that a fast-germinating seed from a slow-germinating family can germinate before a slow germinating seed from a fast germinating family. Usually smaller seedlings caused by late germination [25].Germination period (GP) in this study estimated on 12th day with latest on 16th day and earliest on 7th day. Highest germination was observed on 12th day indicating that imbibition of water occurs slowly or reduction in osmotic potential to activate biological process for essential germination [26]. There is no germination was observed after 12 days which could be useful for successful seedling establishment program to ensure uniform seedling growth.

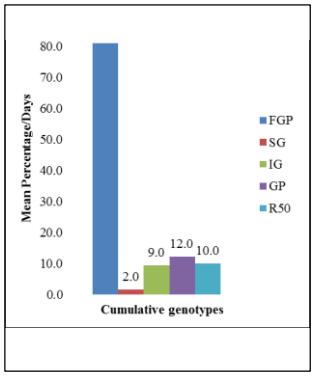

Figure.2 Graph shows the mean performance of germination traits

Table 1 Results of one way ANOVA showing effect of genotypes on the germination traits in different types *Capsicum annum*

Source of variation	Df	Mean Square Values				
		FGP	SG	IG	T50	GP
Genotypes	92	1439.70*	2.753*	29.258*	26.013*	23.878*
Error	182	115.350	0.039	1.713	2.341	2.914
Total	279	-	-	-	-	-

*Significant at p<0.05, ns=not significant

Final germination percentage (FGP), Speed of germination (SG), Initiation of germination (IG), Days to 50% germination (T50) and Peak period of germination (GP)

CONCLUSION

It is concluded that variation in terms of genetic content accurs within same species of *Capsicum annuum.* The variability recorded in present studies reflects the possibility to improve the germination percentage, speed of germination initiation through hybridization.

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