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Effect of Seed Priming on the Vegetative Growth and Yield of *Capsicum annum* L. and *C. frutescens* L.

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Abstract
Pepper (*Capiscum*) Solanaceae is a spice and fruit vegetable cultivated worldwide. A lot of research effort have been done to improve the hybrids and varieties of about four popular species. This study focused its research attention on the effect of seed priming on vegetative growth and yield performance of some varieties of two species of *Capsicum annum* and *Capsicum frutescens*. These include *C. annum* var. *abbreviatum*; *C. annum* var. *grossium*; *C. frutescens* var. *accuminatum*; *C. frutescens* var. *minima*. The seed procured were tested for viability using the floatation method. Seeds of all the varieties were primed in 100 mM Nacl and distiled water for 10 h and 20 h respectively. Primed seeds were prepared for germination in black polythene planting bags, emerged seedling were nursed for 10-13 weeks until fruiting stage. The experiment was carried out from July to October 2018, in the screen house of the Department of Pure and Applied Botany of the Federal University of Agriculture, Abeokuta Nigeria. Hydropriming of seeds for 10 hours enhanced leave production significantly ($P<0.05$) in *C. annum* var. *grossium* and *C. frutescens* var. *accuminatum*. The 10 h-halopriming seeds of *C.frustescen* var. *accuminatum* had more leaves. The 10 h-hydroprimed seeds of *C. frustescen* var. *minima* significantly ($P<0.05$) gave rise to plants with more yield across all varieties considered.

Keywords: Halopriming, Hydropiming, Sodium chloride, Seed pretreatment, Pepper plant.

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Introduction

Pepper belongs to the Solanaceae family of vegetables grown for their fruits. It (*Capsicum* species) is a spice and fruit vegetables widely cultivated in the world. It is very important in human diet (Dias *et al*. 2013; Wahyuni *et al.* 2013). It is widely used as a vegetable and contains several metabolites that are associated with enhancing human health, including phytonutrients such as vitamin C, vitamin A, and essential minerals (Zhuang *et al.* 2012). After germination, the vegetative growth rates and strength, influences the yield rate which projects the importance of the crop in the society. Seed priming initiates some biochemical changes in the metabolism within the seed inducing germination capacity, improves the seed performance and also helps the seedlings to alleviate the detrimental effects of various stresses (Kolothodi and Jos 2014).

The vegetative phase of plant carries the important degree in the growth cycle. Been the major photosynthetic stage where plants are physiologically able to faster or better activate defense responses or both to critically influence the reproductive phase (Khan *et al.,* 2008). The early germination rate is very important in the vegetative growth and yield of pepper plant and due to high demand for pepper plant and its economic importance, there is need for seed germination improvement. Therefore, a focused on the effects of seed priming on vegetative growth and yield performance of *Capsicum annum* and *Capsicum frutescens* species of pepper was considered.

Materials and Methods

Seed source

Seeds of *Capiscum* species and varieties used were procured from the Ogun State Ministry of Agriculture, Abeokuta, Ogun state.

Viability Test

The viability of the seeds of *C. annuum and C. frutescens* used was determined by floating method. This was done by soaking the seeds in water. The viable seeds settled at the bottom of the container, while the other seeds floated on the surface and are considered non-viable. The seeds that settle at the bottom of the container are considered viable and used for the experiments (Mensah and Ekeke, 2016).

Pretreatment Methods

The seeds were pre-treated using hydro-priming and halo-priming. The seeds were soaked in distilled water (DW) for the hydro-priming pretreatment for 10 and 20 hours respectively (Maiti *et al.,* 2011). For the halo-priming, seeds were soaked in 100 mM of NaCl for 10 and 20 hours respectively. At the end of the pretreatment time, the seeds were washed several times in distilled water, hydrated at room temperature for 24 hours for seed to regain germination status before been planted (Bojović *et.al.,* 2010; Mait *et al.,* 2011). The non-primed seeds served as control.

Experimental Design

The potted experiment was set up in Complete Randomised Designed laid out in factorial arrangement.

Green House Experiment

Three pre-treated seeds from each of the two pretreatments were planted at 1.5 cm soil depth in black polythene bags already filled with sandy-loam soil. Each treatment was replicated three times (Hussein *et al., 2012*). After emergence, each seedling was watered at the interval of 2 days until fruiting stage 10 – 13 weeks after planting (WAP)

Data collection

Data were collected on the following parameters: Number of leaves per plant per treatment.

Leaf area: Leaf area was determined using Linear equation described by Salau *et.al.* (2008) as follow:

$$Y=-1.45 +0.65(L\times B)$$

Where Y=leaf area (cm^2)
L=Length of the leaf
B= Breadth of the leaf

Plant height per plant per treatment, Number of days to flowering per plant per treatment, Number of flowers per plant per treatment, Number of fruit per plant per treatment.

Statistical Analysis

The data collected were subjected to Analysis of variance (ANOVA) at 5% probability level while separation of means was done using Duncan's Multiple Range Test (DMRT) also at 5% probability level.

Results

Pretreatment of *Capsicum sp* seeds before planting shows various effects both on the germination, vegetative growth and yield. The effects of hydro-priming and halo-priming on the average number of leaves from three weeks after planting (3 WAP) to (13 WAP) on four varieties of *Capsicum sp.* are presented in table 1a and 1b. There was progressive increase in number of leaves in all the pepper species used. For *C. annum* var. *abbreviatum*, the control has more average number leaves (39.67) than the pretreated ones from 3 WAP till 13 WAP while the hdyro primed variety at 13 WAP for ten hours has more average number leaves (8.00) than the 20 hours primed (7.00). The ten hours halo primed at 13 WAP has more average number of leaves (22.00) than the twenty hours halo primed (7.67). Overall ten hours halo primed has the highest average number of leaves (22.00) amidst both primed variety of *Capsicum annum var. abbruviatum*.

The hydro primed of *Capsicum annum* var. *grossium*, for 10 hours has more average number of leaves (13) than the 20 h hydro primed (8) while the halo primed for 20 h has a consistent increase in the average number of leaves, this dropped at the harvesting stage (7.67). In all, the 10 h hydro primed had more average number of leaves (13) at 13WAP than all other primed variety of *Capsicum annum* var. grossium.

Seedlings form the primed *Capsicum frutescens* var. *accuminatum* had more average number of leaves at 13 WAP than the control. The 10 h hydro primed had more average number of leaves (21.00) than all the primed variety of *Capsicum frutescens* var. *accuminatum*. The 10 h halo primed variety had more average number of leaves (20) among the halo primed.

Hydro primed variety of *Capsicum frutescens* var. *minima* has better performance as to average number of leaves above all primed variety while the 10 h hydro primed variety of *Capsicum frutescens* var. *minima* has the highest average number of leaves (30.00) at 13 WAP. The 20 h hydro primed had (26) average number of leaves at 13 WAP. The 10 h halo primed had (21) average number of leaves above the 20 h halo primed with (17) the control had the least average number of leaves (9). Across the four varieties of *Capsicum*, the 10 h hydro primed for *Capsicum frutescens* var. *minima* had the highest average number of leaves (30.00). This showed a better performance among all the four varieties.

Effect of priming on plant height

The effect of priming on the plant height of *Capsicum annum* and *Capsicum frutescens* from 3 WAP are presented in Table 2a and 2b. For *Capsicum annum* var. *abbruviatum*. The growth from 3 WAP for all the primed and control had a progressive growth till 13 WAP with the control having the highest height of 21.50 cm. This is followed by the haloprimed for 10 h (16.17 cm). The 10 h hydroprimed (12.50 cm) and 20 h haloprimed with 20 h hydroprimed had the least plant height 8.50 cm.

Capsicum annum var. *grossum* reveals that at 13 WAP 20 h hydroprimed had the highest plant height (14.53 cm) followed by the 10 h hydroprimed (13.67 cm). The haloprimed for 20 h had (13.00 cm), 10 h haloprimed (12.33 cm) and the control been the least with 12.50 cm.

Ten hours haloprimed *Capsicum frutscens* var. *accuminatum* showed the highest plant height (25.00 cm) followed by hydroprimed (19.83 cm), 20 h haloprimed (18.00 cm) and the control (15.50 cm). The 20 h hydroprimed had the least height 15.00 cm.

While *Capsicum frutscens* var. *minima* showed a progressive height growth all through the growth phase with 10 h hydroprimed having the highest height of 27.33 cm followed by 20 h hydroprimed 25.67 cm. The 10 h haloprimed had 22.77 cm followed by the 20 h hydroprimed 15.83 cm and the control 13.00 cm.

Effect of priming on the leaf area

The average leaf area for all primed *capsicum* varieties from 3 WAP to 13 WAPis as shown in table 3a and 3b. The 10 h haloprimed of *Capsicum annum* var. *abbreviatum* showed the highest leaf area 26.10 cm^2 followed by both 10 h and 20 h hydroprimed 26.00 cm^2 and the control 25.60 cm^2. The 20 h haloprimed had the least leaf area of 24.00 cm^2

The 10 h hydroprimed *Capsicum annum* var. *grossum* showed the highest leaf area 25.00 cm^2 followed by the control 22.00 cm^2. The 20 h hydroprimed had 21.10 cm^2 followed by 10 h haloprimed 21.00 cm^2 and 20 h haloprimed with the least leaf area 19.80 cm^2.

The 10 h hydroprimed *Capsicum frutescens* var. *accuminatum* showed the highest leaf area of 25.00 cm^2 followed by 20 h hydroprimed and control 24.00 cm^2. The 10 h haloprimed with 23.00 cm^2 and 20 h haloprimed for had the least leaf area of 21.00 cm^2.

The 10 h hydroprimed *Capsicum frutescens* var. *minima* has the highest leaf area of 16.50 cm^2 followed by 10 h haloprimed and 20 h hydroprimed with 15.00 cm^2 each. The 20 h haloprimed had the least leaf area of 14.10 cm^2

Table 1a: Effect of priming on average number of leaves per plant varieties.

Varieties	Treatment	NOL WK3	NOL WK4	NOL WK5	NOL WK6	NOL WK7	NOL WK8
Capsicum annum var. *abbruviatum*	HyT1	6.00 ± 0.00^{bcd}	7.00 ± 0.58^{bcde}	7.33 ± 1.33^{cde}	7.67 ± 1.45^{b}	9.33 ± 0.67^{bcd}	12.00 ± 1.73^{bc}
	HaT1	5.33 ± 0.67^{bcd}	5.33 ± 1.33^{de}	6.00 ± 1.15^{cde}	9.33 ± 3.93^{b}	10.33 ± 2.60^{bcd}	14.00 ± 3.06^{bc}
	HyT2	5.33 ± 0.88^{bcd}	6.33 ± 1.45^{cde}	6.33 ± 1.45^{cde}	6.67 ± 1.33^{b}	8.67 ± 1.33^{cd}	8.33 ± 0.88^{c}
	HaT2	5.33 ± 0.33^{bcd}	6.00 ± 0.00^{cde}	6.67 ± 0.67^{cde}	7.67 ± 0.33^{b}	8.67 ± 0.67^{cd}	9.67 ± 0.67^{c}
	Control	**8.00 ± 0.58^{a}**	**11.00 ± 0.58^{a}**	**15.00 ± 1.15^{a}**	**28.67 ± 1.45^{a}**	**30.00 ± 0.58^{a}**	**33.33 ± 1.76^{a}**
Capsicum frutescens var. *accuminatum*	HyT1	6.00 ± 0.00^{bcd}	6.67 ± 0.33^{bcde}	6.33 ± 1.33^{cde}	11.00 ± 2.08^{b}	10.00 ± 2.52^{bcd}	12.33 ± 4.84^{bc}
	HaT1	7.00 ± 0.58^{ab}	7.33 ± 0.88^{bcd}	7.33 ± 1.76^{cde}	11.00 ± 2.65^{b}	10.33 ± 2.19^{bcd}	15.67 ± 4.33^{bc}
	HyT2	5.33 ± 0.67^{bcd}	7.33 ± 1.33^{bcd}	8.33 ± 0.33^{bcd}	10.33 ± 1.86^{b}	10.00 ± 2.00^{bcd}	12.67 ± 3.71^{bc}
	HaT2	6.33 ± 0.33^{abc}	9.33 ± 0.33^{ab}	9.67 ± 0.33^{bc}	12.00 ± 1.16^{b}	11.33 ± 1.33^{bcd}	11.67 ± 2.40^{bc}
	Control	**6.00 ± 0.58^{bcd}**	**7.00 ± 0.58^{bcde}**	**11.00 ± 0.58^{b}**	**13.00 ± 0.58^{b}**	**11.00 ± 0.58^{bcd}**	**17.00 ± 1.15^{bc}**
Capsicum annum var. *grossium*	HyT1	5.33 ± 0.67^{bcd}	6.33 ± 0.33^{bcde}	6.67 ± 0.67^{cde}	7.33 ± 1.33^{b}	8.00 ± 1.53^{cd}	8.33 ± 1.67^{c}
	HaT1	6.00 ± 0.00^{bcd}	6.00 ± 0.58^{cde}	5.00 ± 0.58^{de}	7.00 ± 0.58^{b}	7.33 ± 1.76^{d}	8.00 ± 0.58^{c}
	HyT2	4.33 ± 0.33^{d}	5.67 ± 0.33^{cde}	7.00 ± 0.58^{bcd}	7.33 ± 1.76^{b}	8.33 ± 0.88^{cd}	9.00 ± 0.58^{c}
	HaT2	6.00 ± 0.00^{bcd}	6.33 ± 0.33^{bcde}	5.00 ± 0.58^{de}	8.00 ± 1.16^{b}	11.00 ± 1.73^{bcd}	9.67 ± 0.67^{c}
	Control	**5.00 ± 0.58^{d}**	**7.00 ± 0.58^{bcde}**	**7.67 ± 0.88^{cde}**	**9.00 ± 0.58^{b}**	**8.00 ± 0.58^{cd}**	**8.00 ± 0.00^{c}**
Capsicum frutescens var. *minima*	HyT1	5.33 ± 0.88^{bcd}	8.33 ± 1.86^{abcd}	9.00 ± 2.08^{bc}	11.67 ± 3.93^{b}	14.67 ± 2.60^{b}	21.00 ± 6.93^{b}
	HaT1	5.00 ± 0.58^{cd}	7.33 ± 0.67^{bcd}	9.00 ± 0.58^{bc}	8.67 ± 1.76^{b}	10.67 ± 1.20^{bcd}	13.67 ± 2.03^{bc}
	HyT2	6.67 ± 0.88^{abc}	8.67 ± 1.45^{abc}	7.67 ± 2.03^{cde}	13.00 ± 2.89^{b}	10.67 ± 1.86^{bcd}	16.00 ± 4.93^{bc}
	HaT2	5.00 ± 0.58^{cd}	8.00 ± 1.16^{bcd}	8.33 ± 0.33^{bcd}	12.00 ± 1.16^{b}	13.00 ± 1.53^{bc}	15.33 ± 1.86^{bc}
	Control	**7.00 ± 0.58^{ab}**	**4.00 ± 0.58^{e}**	**4.00 ± 1.15^{e}**	**7.00 ± 1.16^{b}**	**7.33 ± 0.88^{d}**	**10.00 ± 1.15^{c}**

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT)

KEY: HyT1- 10h Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming, NOL: Number of Leaves, WK: Week

Table 1b: Effect of priming on number of leaves per plant varieties.

Varieties	Treatment	NOL WK9	NOL WK10	NOL WK11	NOL WK12	NOL WK13
Capsicum annum	HyT1	11.00±1.16^{cdef}	11.00±1.16^{bcdef}	8.00±0.58^{cd}	8.00±0.58^{cd}	8.00±1.53^{d}
var. abbruviatum	HaT1	15.00±1.73^{bcde}	15.00±1.73^{bcde}	20.33±6.84^{bcd}	20.33±6.84^{bcd}	22.00±6.11^{bcd}
	HyT2	9.33±1.20^{def}	9.33±1.20^{def}	8.67±1.67^{cd}	8.67±1.67^{cd}	7.00±1.00^{d}
	HaT2	9.00±2.00^{def}	9.00±2.00^{def}	7.67±1.20^{cd}	7.67±1.20^{cd}	7.67±1.33^{d}
	Control	**46.67±0.88^{a}**	**42.00±1.16^{a}**	**38.67±0.88^{a}**	**37.00±1.16^{a}**	**39.67±2.73^{a}**
Capsicum frutescens	HyT1	15.33±3.76^{bcde}	15.33±3.76^{bcde}	22.67±5.90^{bc}	22.67±5.90^{bc}	21.00±4.16^{bcd}
var. accuminatum	HaT1	19.67±4.84^{b}	19.67±4.84^{b}	20.67±5.90^{bcd}	20.67±5.90^{bcd}	20.67±6.33^{bcd}
	HyT2	14.00±3.51^{bcdef}	14.00±3.51^{bcdef}	12.33±3.53^{cd}	12.33±3.53^{cd}	14.00±6.51^{bcd}
	HaT2	15.67±1.76^{bcde}	15.67±1.76^{bcde}	12.33±3.18^{cd}	12.33±3.18^{cd}	15.00±3.51^{bcd}
	Control	**12.67±0.33^{bcdef}**	**12.00±0.58^{bcdef}**	**12.33±0.33^{cd}**	**11.00±0.58^{cd}**	**6.67±0.88^{d}**
Capsicum annum	HyT1	11.67±1.76^{bcdef}	11.33±2.03^{bcdef}	14.33±6.74^{bcd}	14.33±6.74^{bcd}	13.33±5.24^{cd}
var. grossium	HaT1	6.33±0.33^{f}	6.33±0.33^{f}	8.33±0.33^{cd}	8.33±0.67^{cd}	7.67±1.45^{d}
	HyT2	8.67±1.45^{ef}	9.00±1.53^{def}	9.33±0.67^{cd}	9.67±0.88^{cd}	7.67±0.33^{d}
	HaT2	9.00±1.00^{def}	8.67±0.88^{ef}	9.67±2.03^{cd}	9.33±2.03^{cd}	6.67±1.76^{d}
	Control	**5.67±0.33^{f}**	**6.00±0.58^{f}**	**6.00±0.58^{d}**	**6.00±0.58^{d}**	**6.67±0.67^{d}**
Capsicum frutescens	HyT1	19.00±5.20^{bc}	19.00±5.20^{bc}	27.67±10.33^{ab}	27.67±10.33^{ab}	30.00±12.50^{ab}
var. minima	HaT1	18.00±1.73^{bc}	18.00±1.73^{bc}	19.67±6.36^{bcd}	19.67±6.36^{bcd}	21.67±8.99^{bcd}
	HyT2	17.33±4.91^{bcd}	17.33±4.91^{bcd}	22.67±5.33^{bc}	22.67±5.33^{bc}	26.67±7.13^{abc}
	HaT2	12.33±0.88^{bcdef}	12.33±0.88^{bcdef}	15.33±2.91^{bcd}	15.33±2.91^{bcd}	17.33±2.73^{bcd}
	Control	**9.00±0.58^{def}**	**8.67±0.33^{ef}**	**10.00±1.16^{cd}**	**10.00±0.58^{cd}**	**9.33±1.45^{d}**

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT).

KEY: HyT1- 10h Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming, PH: Plant Height, WK: Week

Table 2a: Effect of priming on plant height per plant varieties.

Varieties	Treatment	PH WK3	PH WK4	PH WK5	PH WK6	PH WK7	PH WK8
Capsicum annum	HyT1	4.73±0.39^{cd}	5.97±0.49^{bcd}	7.67±0.88^{abcd}	8.50±1.04^{bcd}	9.67±1.20^{abcd}	11.17±2.17^{abcd}
var. abbruviatum	HaT1	4.67±0.09^{cd}	4.47±0.78^{d}	6.83±0.73^{bcd}	8.83±1.45^{cd}	10.17±1.69^{abcd}	11.67±1.88^{abcd}
	HyT2	4.00±0.50^{cd}	4.27±0.72^{d}	5.33±0.88^{cd}	6.33±0.73^{d}	7.00±1.15^{d}	7.17±1.01^{d}
	HaT2	4.23±0.39^{cd}	5.23±0.48^{cd}	6.50±0.76^{bcd}	6.83±0.88^{d}	8.00±1.04^{cd}	8.67±1.17^{cd}
	Control	**7.33±0.88^{ab}**	**10.50±0.29^{a}**	**12.00±0.58^{a}**	**14.00±0.29^{a}**	**16.00±0.29^{abc}**	**17.50±0.29^{abc}**
Capsicum frutescens	HyT1	5.43±0.07^{bcd}	6.80±0.72^{bcd}	10.00±1.73^{ab}	12.50±2.75^{abc}	14.83±3.48^{abcd}	16.83±4.49^{abc}
Var. accuminatum	HaT1	7.93±0.83^{a}	9.07±0.97^{ab}	12.00±1.44^{a}	13.83±1.69^{ab}	15.17±2.33^{abcd}	19.50±3.00^{a}
	HyT2	4.27±0.64^{cd}	6.60±1.30^{bcd}	8.17±1.59^{abcd}	9.50±2.02^{abcd}	11.00±3.21^{abcd}	13.13±3.44^{abcd}
	HaT2	6.27±0.43^{abcd}	8.10±0.40^{abc}	10.67±0.83^{bc}	11.67±0.88^{abcd}	14.17±2.24^{abcd}	15.33±2.62^{abcd}
	Control	**6.50±0.29^{abc}**	**5.97±0.03^{bcd}**	**7.00±0.12^{bcd}**	**10.00±0.58^{abcd}**	**12.00±0.58^{abcd}**	**14.50±0.29^{abcd}**
Capsicum annum	HyT1	4.53±0.79^{cd}	5.57±1.25^{cd}	7.00±1.44^{bcd}	9.17±1.01^{abcd}	10.17±0.44^{abcd}	11.33±0.17^{abcd}
Var. grossium	HaT1	5.50±1.44^{bcd}	7.67±0.93^{abc}	9.17±0.93^{abc}	10.50±1.32^{abcd}	12.33±1.17^{abcd}	12.33±1.17^{abcd}
	HyT2	5.07±0.20^{bcd}	5.93±0.81^{bcd}	8.53±2.02^{abcd}	9.53±2.02^{abcd}	11.03±2.31^{abcd}	11.83±2.74^{abcd}
	HaT2	5.33±1.59^{bcd}	6.80±0.72^{bcd}	8.00±0.50^{abcd}	9.67±1.01^{abcd}	12.50±3.28^{abcd}	12.50±3.28^{abcd}
	Control	**4.50±0.12^{cd}**	**5.23±0.15^{cd}**	**7.00±0.12^{bcd}**	**8.70±0.12^{abcd}**	**9.00±0.12^{bcd}**	**10.00±0.17^{bcd}**
Capsicum frutescens	HyT1	4.37±1.02^{cd}	5.77±1.72^{cd}	7.33±1.74^{bcd}	9.67±1.92^{abcd}	17.00±4.00^{ab}	17.00±4.00^{abc}
Var. minima	HaT1	4.47±0.13^{cd}	6.50±0.29^{bcd}	7.50±0.29^{bcd}	8.83±0.93^{abcd}	15.33±1.42^{abcd}	15.33±1.42^{abcd}
	HyT2	6.20±1.36^{abcd}	7.67±2.35^{abc}	9.50±3.40^{abc}	12.33±3.90^{abc}	18.00±6.25^{a}	18.00±6.25^{ab}
	HaT2	4.63±0.38^{cd}	5.43±0.47^{cd}	7.17±1.48^{bcd}	8.33±1.36^{cd}	11.83±2.03^{abcd}	11.83±2.03^{abcd}
	Control	**3.90±0.06^{d}**	**4.00±0.06^{d}**	**4.30±0.12^{d}**	**6.60±0.17^{d}**	**8.50±0.06^{cd}**	**9.00±0.12^{bcd}**

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT).

Table 2b: Effect of priming on plant height per plant varieties.

Varieties	Treatment	PH WK9	PH WK10	PH WK11	PH WK12	PH WK13
Capsicum annum	HyT1	11.50±2.25^{bcd}	11.67±2.17^{bcd}	12.17±2.17^{cde}	12.17±2.17^{de}	12.50±2.02^{cdef}
var. abbruviatum	HaT1	13.17±2.62^{abcd}	13.67±2.80^{abcd}	14.33±2.96^{abcde}	14.67±3.00^{bcde}	16.17±3.66^{abcdef}
	HyT2	8.17±0.73^{d}	8.23±0.79^{d}	8.33±0.88^{e}	8.33±0.88^{e}	8.50±0.87^{f}
	HaT2	9.33±0.88^{d}	9.50±0.76^{cd}	10.00±0.76^{de}	10.17±0.93^{de}	10.10±1.10^{ef}
	Control	**19.20±0.31**^{abc}	**19.33±0.44**^{abc}	**20.00±0.29**^{abcde}	**20.17±0.60**^{abcde}	**21.50±0.29**^{abcde}
Capsicum frutescens	HyT1	17.67±4.33^{abcd}	18.50±4.65^{abcd}	19.33±4.98^{abcde}	20.17±4.85^{abcde}	19.83±5.26^{abcdef}
Var. accuminatum	HaT1	21.17±3.61^{a}	22.33±3.71^{a}	23.33±3.98^{abc}	24.50±4.31^{abc}	25.00±4.58^{abc}
	HyT2	14.33±3.48^{abcd}	14.83±3.77^{abcd}	15.17±3.92^{abcde}	15.67±4.10^{abcde}	15.00±3.97^{bcdef}
	HaT2	16.33±2.68^{abcd}	16.83±2.77^{abcd}	17.33±2.89^{abcde}	17.83±3.03^{abcde}	18.00±3.04^{abcdef}
	Control	**15.50±0.17**^{abcd}	**16.00±0.12**^{abcd}	**16.50±0.12**^{abcde}	**17.00±0.12**^{abcde}	**15.50±0.17**^{abcdef}
Capsicum annum	HyT1	12.33±0.33^{abcd}	12.83±0.83^{abcd}	13.33±1.33^{bcde}	14.17±2.17^{bcde}	13.67±2.19^{bcdef}
Var. grossium	HaT1	13.17±1.09^{abcd}	13.00±1.00^{abcd}	12.83±0.93^{bcde}	12.67±0.88^{cde}	12.33±0.88^{def}
	HyT2	12.77±2.17^{abcd}	12.83±2.17^{abcd}	13.27±2.17^{bcde}	14.03±1.73^{bcde}	14.53±1.44^{bcdef}
	HaT2	12.77±3.15^{abcd}	12.67±3.18^{abcd}	12.83±3.35^{bcde}	13.00±3.51^{cde}	13.00±3.51^{cdef}
	Control	**10.50±0.12**^{cd}	**10.80±0.06**^{cd}	**11.00±0.12**^{de}	**12.00±0.58**^{de}	**12.50±0.23**^{cdef}
Capsicum frutescens	HyT1	19.50±5.07^{abc}	22.67±6.89^{a}	25.67±8.41^{a}	27.17±9.18^{a}	27.33±9.28^{a}
Var. minima	HaT1	17.67±2.13^{abcd}	19.33±1.76^{abc}	20.67±1.86^{abcd}	22.00±2.00^{abcd}	22.77±2.13^{abcd}
	HyT2	20.17±6.41^{ab}	22.17±6.87^{ab}	24.00±7.00^{ab}	25.50±7.29^{ab}	25.67±7.16^{ab}
	HaT2	12.83±2.49^{abcd}	13.67±2.73^{abcd}	15.17±3.22^{abcde}	15.67±3.18^{abcde}	15.83±3.38^{abcdef}
	Control	**10.00±0.06**^{cd}	**10.00±0.12**^{cd}	**10.00±0.29**^{de}	**10.00±0.17**^{de}	**13.00±0.12**^{cdef}

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT).

KEY: HyT1- 10h Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming, PH: Plant Height, WK: Week

Table 3a: Effect of priming on leaf area per plant varieties.

Varieties	Treatment	LA WK3	LA WK4	LA WK5	LA WK6	LA WK 7	LA WK8
Capsicum annum	HyT1	12.00±0.58^{a}	13.00±0.58^{a}	15.00±0.58^{a}	16.50±0.35^{a}	19.00±0.58^{a}	23.00±0.35^{a}
var. abbruviatum	HaT1	9.00±0.58^{bcde}	10.00±0.58^{cd}	11.00±0.58^{cd}	13.10±0.35^{cde}	14.00±0.58^{cd}	16.00±0.58^{cd}
	HyT2	10.00±0.58^{b}	11.00±0.58^{bc}	12.00±0.58^{bc}	13.60±0.35^{bcd}	15.00±0.58^{bc}	18.00±0.58^{b}
	HaT2	12.00±0.58^{a}	12.00±0.58^{ab}	13.00±0.58^{b}	12.00±0.58^{def}	13.10±0.35^{de}	14.00±0.58^{ef}
	Control	**8.80±0.35^{bcde}**	**9.00±0.58^{de}**	**11.00±0.58^{cd}**	**12.80±0.35^{cde}**	**14.10±0.35^{cd}**	**14.00±0.58^{ef}**
Capsicum							
frutescens	HyT1	8.00±0.58^{de}	10.00±0.58^{cd}	13.00±0.58^{b}	14.00±0.58^{bc}	16.00±0.58^{b}	21.60±0.35^{a}
var. accuminatum	HaT1	7.70±0.06^{e}	8.00±0.58^{e}	11.00±0.58^{cd}	13.00±0.58^{cde}	15.07±0.09^{bc}	18.10±0.35^{b}
	HyT2	8.30±0.06^{cde}	9.00±0.58^{de}	12.00±0.58^{bc}	14.00±0.58^{bc}	15.50±0.35^{bc}	18.70±0.35^{b}
	HaT2	8.20±0.06^{cde}	9.20±0.35^{cde}	10.00±0.58^{d}	12.00±0.58^{def}	13.00±0.58^{de}	15.00±0.58^{cde}
	Control	**9.00±0.58^{bcde}**	**10.00±0.35^{cd}**	**11.00±0.58^{cd}**	**13.00±0.58^{def}**	**14.50±0.35^{bcd}**	**15.10±0.35^{cde}**
Capsicum annum	HyT1	9.00±0.58^{bcde}	10.00±0.58^{cd}	11.00±0.58^{cd}	15.00±0.58^{b}	18.00±0.58^{a}	22.00±0.35^{a}
var. grossuim	HaT1	8.20±0.06^{cde}	9.80±0.35^{cd}	13.00±0.58^{b}	14.20±0.35^{bc}	14.00±0.58^{cd}	16.10±0.35^{c}
	HyT2	9.20±0.35^{bcde}	10.00±0.58^{cd}	12.00±0.58^{bc}	13.00±0.58^{cde}	15.20±0.35^{bc}	16.00±0.58^{cd}
	HaT2	9.37±0.37^{bcd}	10.00±0.58^{cd}	12.00±0.58^{bc}	13.50±0.35^{bcd}	14.10±0.35^{cd}	14.50±0.35^{de}
	Control	**9.67±0.88^{bc}**	**11.00±0.58^{bc}**	**12.60±0.35^{bc}**	**14.00±0.58^{bc}**	**15.10±0.35^{bc}**	**15.00±0.58^{cde}**
Capsicum							
frutescens	HyT1	8.00±0.58^{de}	10.00±0.58^{cd}	11.00±0.58^{cd}	12.00±0.58^{def}	13.10±0.35^{de}	13.00±0.58^{fg}
var. minima	HaT1	8.80±0.06^{bcde}	9.00±0.58^{de}	10.00±0.58^{d}	11.00±0.58^{f}	11.00±0.58^{f}	12.10±0.35^{g}
	HyT2	8.60±0.06^{bcde}	9.60±0.35^{cde}	10.00±0.58^{d}	10.50±0.35^{f}	11.20±0.35^{f}	12.00±0.58^{g}
	HaT2	8.00±0.58^{de}	9.20±0.35^{cde}	9.90±0.35^{d}	10.80±0.35^{f}	11.00±0.58^{f}	11.90±0.35^{g}
	Control	**8.00±0.58^{de}**	**10.00±0.58^{cd}**	**11.00±0.58^{cd}**	**11.80±0.35^{ef}**	**12.10±0.35^{ef}**	**12.00±0.58^{g}**

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT).

KEY: HyT1- 10h Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming LA: Leaf area, WK: Week

Table 3b: Effect of priming on leaf area per plant varieties.

Varieties	Treatment	LA WK9	LA WK10	LA WK11	LA WK12	LA WK13
Capsicum annum	HyT1	$24.00±0.58^{a}$	$26.00±0.58^{a}$	$28.00±0.58^{a}$	$27.80±0.35^{a}$	$26.00±0.58^{a}$
var. abbruviatum	HaT1	$17.70±0.35^{de}$	$19.00±0.58^{de}$	$22.00±0.58^{d}$	$25.00±0.58^{bc}$	$26.10±0.35^{a}$
	HyT2	$19.60±0.35^{c}$	$20.00±0.58^{cd}$	$24.00±0.58^{bc}$	$26.00±0.58^{b}$	$26.00±0.58^{a}$
	HaT2	$15.00±0.58^{g}$	$17.00±0.58^{fg}$	$20.00±0.58^{e}$	$21.00±0.58^{e}$	$24.00±0.58^{bc}$
	Control	$\mathbf{15.00±0.58^{g}}$	$\mathbf{17.67±0.33^{ef}}$	$\mathbf{21.80±0.35^{d}}$	$\mathbf{25.00±0.58^{bc}}$	$\mathbf{25.60±0.35^{ab}}$
Capsicum frutescens	HyT1	$22.00±0.58^{b}$	$24.00±0.58^{b}$	$24.80±0.35^{b}$	$26.00±0.58^{b}$	$25.00±0.58^{ab}$
var. accuminatum	HaT1	$18.90±0.35^{cd}$	$19.00±0.58^{de}$	$20.00±0.58^{e}$	$21.00±0.58^{e}$	$23.00±0.58^{cd}$
	HyT2	$20.00±0.58^{c}$	$21.00±0.58^{c}$	$22.00±0.58^{d}$	$23.00±0.58^{d}$	$24.00±0.58^{bc}$
	HaT2	$17.17±0.61^{ef}$	$18.00±0.58^{ef}$	$20.00±0.58^{e}$	$21.10±0.35^{e}$	$21.00±0.58^{ef}$
	Control	$\mathbf{16.00±0.58^{fg}}$	$\mathbf{18.00±0.58^{ef}}$	$\mathbf{23.00±0.58^{cd}}$	$\mathbf{23.80±0.35^{cd}}$	$\mathbf{24.00±0.58^{bc}}$
Capsicum annum	HyT1	$22.00±0.58^{b}$	$22.90±0.35^{b}$	$23.00±0.58^{cd}$	$24.00±0.58^{cd}$	$25.00±0.58^{ab}$
var. grossuim	HaT1	$16.00±0.58^{fg}$	$18.00±0.58^{ef}$	$20.00±0.58^{e}$	$23.10±0.35^{d}$	$21.00±0.58^{ef}$
	HyT2	$18.00±0.58^{de}$	$19.00±0.58^{de}$	$20.00±0.58^{e}$	$21.00±0.58^{e}$	$21.10±0.35^{ef}$
	HaT2	$16.10±0.35^{fg}$	$16.00±0.58^{g}$	$19.00±0.58^{f}$	$20.00±0.58^{e}$	$19.80±0.35^{f}$
	Control	$\mathbf{15.50±0.35^{g}}$	$\mathbf{17.00±0.58^{fg}}$	$\mathbf{18.20±0.35^{f}}$	$\mathbf{21.00±0.58^{e}}$	$\mathbf{22.00±0.58^{de}}$
Capsicum frutescens	HyT1	$13.00±0.58^{h}$	$14.00±0.58^{h}$	$15.80±0.35^{g}$	$16.00±0.58^{f}$	$16.50±0.35^{g}$
var. minima	HaT1	$12.60±0.35^{h}$	$12.90±0.35^{h}$	$13.00±0.58^{h}$	$14.10±0.35^{g}$	$15.00±0.35^{gh}$
	HyT2	$12.50±0.35^{h}$	$13.10±0.35^{h}$	$13.80±0.35^{h}$	$14.00±0.58^{g}$	$15.00±0.58^{gh}$
	HaT2	$12.00±0.58^{h}$	$12.50±0.35^{h}$	$13.10±0.35^{h}$	$13.00±0.58^{g}$	$14.00±0.58^{h}$
	Control	$\mathbf{12.37±0.37^{h}}$	$\mathbf{12.80±0.35^{h}}$	$\mathbf{13.00±0.58^{h}}$	$\mathbf{13.50±0.35^{g}}$	$\mathbf{14.10±0.35^{h}}$

Mean values± S.E within the same column having different superscripts are significantly different at $P < 0.05$ by Duncan Multiple Range Test (DMRT).

KEY: HyT1- 10h Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming LA: Leaf area, WK: Week

Effects of priming on number of flowers

The effects of priming on number of flowers per plant varieties are presented in figure 4.The 10 h haloprimed seedlings of *Capsicum annum* var. *abbreviatum* had the highest number of flowers (13), 20 h hydroprimed (4.67), 20 h haloprimed and 10 h hydroprimed had 3 flowers with the unprimed having 8 flowers

The 20 h hydroprimed *Capsicum annum* var. *grossum* had the highest number of flowers (13.67) followed by 10 h hydroprimed 8 then 10 h haloprimed 6.33 flowers. The 20 h haloprimed and control had the least number of 4 flowers.

The 20 h haloprimed *Capsicum frutescens* var. *accuminatum* showed the highest numbers of flower (11) followed by 20 h hydroprimed (8.33), 10 h haloprimed (8). The 10 h hydroprimed (7) with the control (5.67) had the least number of flowers. In *Capsicum frutescens* var, *minima* shows 10 h hydroprimed showed the highest number of flowers (18) followed by 10 h haloprimed (11) with the 20 h hydroprimed and 20 h haloprimed having 9.67 and control with the least number of flowers (7.67).

Effects of priming on number of fruits.

The effects of priming on the average number of fruits per plant varieties are as presented in figure 5. In *Capsicum annum* var. *abbreviatum* seedlings both the control and 10 h haloprimed had the highest number of fruits (6) while 20 h hydroprimed had 5. This is followed by 10 h hydroprimed (3.33) with 20 h haloprimed having the least fruit number (2.67). The 20 h hydroprimed *Capsicum annum* var. *grossum* had the highest average number of fruits (7.67) followed by 10 h hydroprimed with (6),10 h haloprimed 4.33 and control 4. The 20 h haloprimed had the least average number of fruits (2).

Capsicum frutescens var. *accuminatum* shows that 10h haloprimed, 20 h hydroprimed and 20 h haloprimed all had the same average number of fruits (4.33) followed by the control (4). The 10 h hydroprimed had the least average number of fruits 3. The 10 h hydroprimed of *Capsicum frutescens* var. *minima* had the highest average number of fruits (16.7), followed by the 10 h haloprimed (11), 20 h hydroprimed (9), 20 h haloprimed (8.67) and control (7).

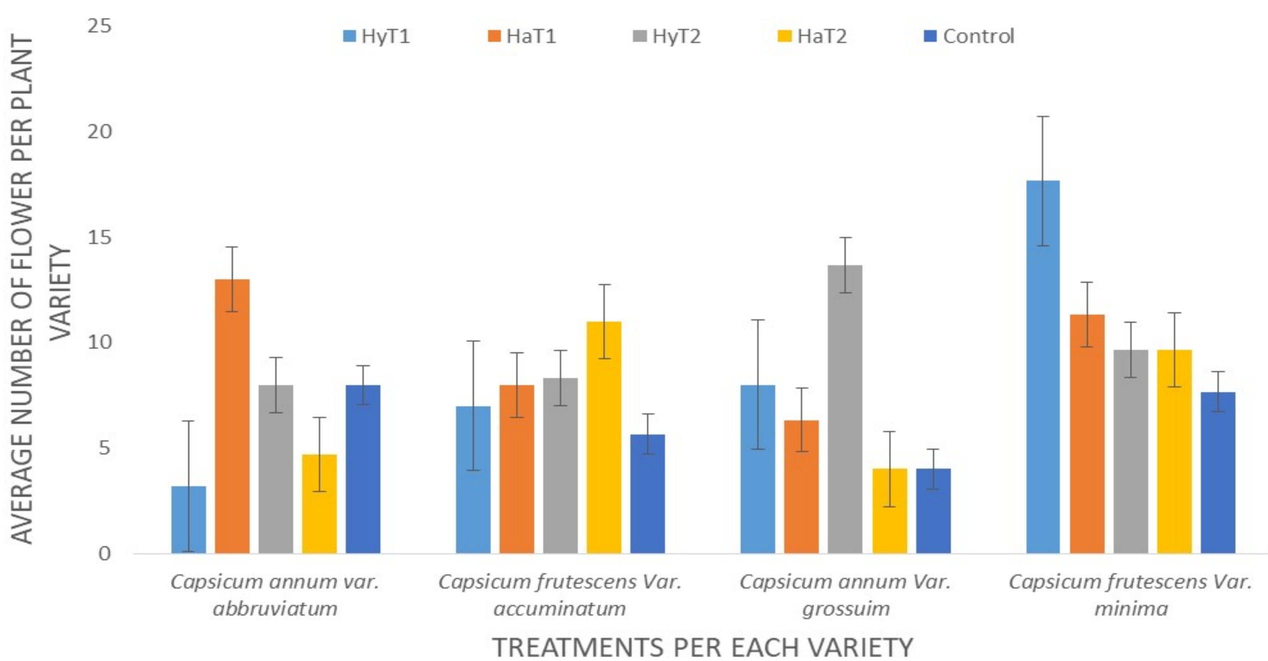

Figure 1: Effect of priming on number of flower per plant varieties

KEY: HyT1 -10h - Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming.

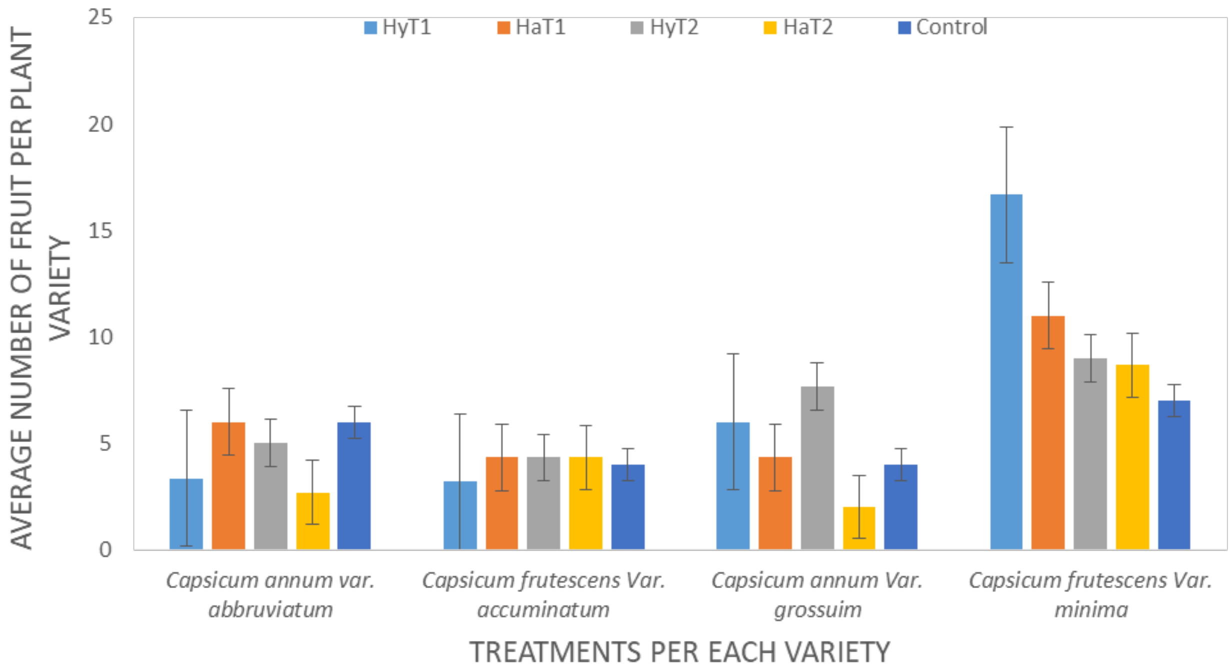

Figure 2: Effect of priming on number of fruit per plant varieties

KEY: HyT1 -10h - Hydrpriming, HyT2- 20h hydropriming, HaT1- 10h Halopriming, HaT2- 20h Halopriming.

Discussion

Priming had significant effect (P > 0.05) on plant height, number of leaves and leaf area across the varieties studied. This is beneficial to the plant for good yield. The differences in plant height may be due to both environmental and genetic potential modalities. However, vegetative and reproductive growth potential of plants is also responsible for superior plant height in seedlings from primed seed. This is a more factor of seedling vigour and established rate of growth. The result is in line with the work of Williams *et al*. (2016) on the comparism of seed priming techniques with regards to germination and growth of watermelon seedlings in laboratory condition. He showed that the growth of watermelon seedlings was significantly affected by different priming treatments. Seed priming with GA_3, KNO_3, $Ca(NO3)_2$ and water (hydropriming) resulted in higher shoot length of watermelon seedlings. These results indicate that the seed priming with gibberellic acid, salts or water were adequate to promote the shoot growth of watermelon. (Batista *et al*., 2015) also reported the efficiency of some priming solutions of GA_3, KNO_3, $Ca(NO3)_2$ and water priming to enhance the shoot growth of pear seedlings compared to unprimed seeds. From the study the plant height (table 2a and 2b) reveal significant increase (P > 0.05) in hydropriming for 10 hours across the all varieties above other priming method which may be due to early germination of seeds. Maiti *et al.* (2011) reported a significant increase on the plant height of chilli pepper on primed seeds in their investigation on seed priming improvement on seedling vigour and yield of few vegetable crops was observed. This is in accordance with the study of Nasrollah *et al.* (2013) on the effect of hydropriming on seed germination seedling growth in sage (*Salvia officinalis* L.) best shoot and height on priming for 12 hours were observed. More leaves were also produced than the unprimed seeds. He further stated that hydropriming increases the activities of antioxidant enzymes like superoxide dismutase (SODs) (are metal-containing enzymes that catalyze the dismutation of superoxide radicals to oxygen and hydrogen peroxide. The enzyme has been found in all aerobic organisms examined where it plays a major role in the defense against toxic-reduced oxygen species, which are generated as byproducts of many biological oxidations. The generation of oxygen radicals can be further exacerbated during environmental adversity and consequently SOD has been proposed to be important for plant stress tolerance), peroxidase, catalase and ascorbate peroxidase which helps in plant growth and are increased significantly by seed priming. The number of leaves (table 1a and 1b) showed significant increase in varieties studied with the hydroprimed for 10 hours showing a more significant increase. This is in accordance with the report of Rajpar *et al.,* (2006) on the effect of seed priming on growth and yield of wheat (*Triticum aestivum* L.) under Non-saline conditions. He concluded that there is decrease in number of leaves during fruiting. This may be ascribed to the fact that plant channels their energy towards flower production as reported by Mahajan *et al.* (2011) while working on seed priming effects on germination, growth and yield of dry direct-seeded rice. Report from Naeem *et al.* (2006) on the effect of seed priming on growth of barley (*Hordeum vulgare*) by using brackish water in salt affected soils also stated that priming with salt caused retardation in plant growth hence the support, why haloprimed seeds gave a lower growth performance. The leaf area (table 3a and 3b) revealed a significant different on primed varieties with hydropriming giving the best improvement over the control. This reflects the effect on photosynthesis and increase growth rate. The observed increase in leaf area can be due to established root system and improved emergence and seedling growth of primed seed as reported by (Arshad *et al.,* 2013). This observation in *Capsicum* coincides with the report of Hafeez *et al.,* (2015) that priming increase the leaf area and chlorophyll contents and improves yield performance in early planting due to increased leaf area index, crop growth and net assimilation rates, and maintenance of green leaf area at maturity. In investigation conducted on seed priming showed enhancement in early seedling vigour, growth and productivity of spring maize. Ahmad Khan and Khan Khalil (2010) in effect of leaf area on dry matter production in aerated mung bean seed. He reported that leaf area is an important variable in the overall plant growth as it's the site for optimum photosynthetic activity which lead to vigorous plant growth and photosynthetic ability and it's further affected by seed priming. Research studies on effect of various sources and duration of priming on spinach seeds (Arshad *et al.,* 2013) had showed that priming of seeds with different chemicals increased number of tillers and leaf area index, dry matter accumulation, growth rate and yield compared with control.

The fruit produced from *Capsicum* varieties study (fig. 2) reveal better performance from primed seed. Hydroprimed treatment gave increased number of fruits. This might be due to increase in leaf area as it gives room for more photosynthetic action. This is also in conjunction with the report of Maiti *et al.* (2011) on seed priming improving seedling vigour and yield of few vegetable crops, whose investigation reveals that primed seed improve the leaves production and gave more yield in hybrid of tomatoes.

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