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EFFECT OF PRE-PLANTING COLD TREATMENT ON THE GROWTH AND DEVELOPMENT OF ONION SEED CROP WITH SPECIAL EMPHASIS ON FLOWERING

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ABSTRACT

This study was stimulated by the problem of onion seed production in Bangladesh and similar regions where seed production is possible only during the short cool winter period after which rapid increase in temperature as well as early shower adversely affect the quality of seed. Experiment was carried out in order to develop suitable production techniques to get high yield and quality of onion seed overcoming the stated adverse situation. The present research was conducted at the Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh and in the Plant Genetic Laboratory of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from 1999 to 2000 to manipulate the control of growth cycle of onion for high yield and production of quality seed. The results revealed that the number of days required for 80% emergence of bulb, plant height, number of leaves per hill, days required to bolting, number of flower per umbel, number of seed set per umbel were significantly influenced by the temperature treatment. Results showed that seed crop development was accelerated by pre-planting cold treatments. Pre-planting cold treated seed crop enhanced bulb emergence and completed vegetative growth earlier, also early initiation of flower stalks, flowering, fruit setting, maturity and consequently quality seed. From pre-planting cold treatment, seed crop was harvested at least 11-14 days before the non-treated ones.

Key Words: Onion seed, pre-planting cold treatment, growth and development, flowering

INTRODUCTION

Onion (*Allium cepa* L., Fam. Alliaceae) is an important spice crop in Bangladesh as well as in the world. It has been domesticated for five thousand years or more and is being extensively cultivated throughout the world (Brewster, 1994). It is widely used as spice,

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salad and dressing. Among the fifteen vegetable and spice crops listed by FAO, onion is the second most important after tomato (Pathak, 1994). Among the spice crops grown in Bangladesh, onion ranks second in area and first in production (BBS, 2000); but its demand exceeds domestic supply and the average yield is low (4.18 t/ha in 1998) as compared to the world average yield (17.27 t/ha). The production of onion was about 143,000 metric tones in about 39.66 thousand hectares of land in Bangladesh during the 1998-99 growing season (BBS, 2000), which does not fulfill the local demand.

The production of onion in Bangladesh largely depends on the availability of seed. Problems is associated with the supply of high quality onion seeds in the country serious. The problem is gradually increasing with increasing problems in the production of seed due to high price of mother bulbs and unpredictable weather conditions. Onion is grown almost in all the districts of Bangladesh, but its seeds are produced in particular areas of Faridpur, Natore, Pabna and Rajshahi districts (Rahim *et al.*, 1993). Enormous differences are observed in average seed yields depending on genotype, locality, season and method of production. The average seed yield in Bangladesh is very low (370 to 500 kg per ha) as compared to some other countries of the world (1000 to 1200 kg per ha; Brewster, 1994). The total production of onion seed in Bangladesh is about 150 metric ton per year, but its requirement is more than 300 metric ton (Rahim *et al.*, 1993). Moreover, the seed available in the market is often of poor quality in respect of germination, vigour and varietal purity. In addition, sometimes, a scarcity of seed severely decreases the production of onion. So the country needs to import a large quantity of onion seeds every year. It has been reported that, 80 metric tones of onion seeds were imported in Bangladesh in the year 1990 at a cost of 160 thousand US Dollar (HRDP, 1995). However, authorized import is very limited, and a huge quantity of seed is smuggled in the country from the neighboring countries. The position creates some unhealthy situations for the onion growing industry of the country. In that situation the Government of the People's Republic of Bangladesh has emphasized on 'seed development' in the Five Year Plan (GOB, 1998). Therefore, an intensive research is needed to produce best quality onion seeds in Bangladesh.

Onion is a photo- and thermo-sensitive crop. Generally the onion seed growers of Bangladesh follow the bulb-to-seed method. Rahim *et al.* (1982) reported that bulb-to-seed method is appropriate for Bangladesh. In the seed to seed method, all the plants do not produce flower in the same season under Bangladesh condition (Rashid, 1976; Rahim *et al.*, 1982). This is due to incomplete vernalization of plants. Being a biennial crop, they normally flower in second season of their development. However, under certain conditions, flowering may occur in the first growing season. In both instances, flowering will occur, provided that plants, which have passed the juvenile phase, are exposed to several environmental factors specially temperatures, which induce and mediate the initiation and the elongation of the inflorescence.

The main objectives of the present study are to reduce the vegetative growth cycle and enhance early flowering, fruiting and maturity in tropical cultivars of onion by using pre-planting cold treatments of bulbs. By accelerating the growth cycle it will be possible to

confine seed production to the cool dry season and thus to avoid the problems of high temperature and rainfall during the flowering and seed maturation period in Bangladesh. This would also improve the quality of produced seeds.

MATERIALS AND METHODS

This experiment was conducted to study the growth and development of onion plants with special emphasis on flowering. The study was carried out with a local cultivar of onion named 'Taherpuri'. All the bulbs of Taherpuri were collected from Taherpur of Rajshahi District. The average bulb size for each experiment used was 10 ± 2 g except the experiment on bulb size. No split bulbs were used as planting materials.

General characteristics of onion cv. Taherpuri: Bulbs are generally non-splitting, single, flask-shaped and good storage quality. Skin color is reddish brown; flesh color is yellowish white, highly pungent and high dry matter content. Leaves are moderately waxy, deep green, erect and tapering towards the end. Diameter of leaves and pseudo-stem are 1.00±0.25 cm and fairly resistant to Alternaria disease (Rahim, 1991).

Treatments: Pre-planting cold treatment plus a control, vis-à-vis i. Pre-planting cold treatment of bulbs at 7°C, ii. Pre-planting cold treatment of bulbs at 12°C, and iii. Bulbs at ambient temperature (30 ± 2°C)

Experimental design: The single factor experiment was conducted in the Randomized Complete Block Design with three replications. Dry sets of onion of about 10-12g (usual size grade for seed production) of a local cv. 'Taherpuri' were planted on 01 November. Pre-planting cold treatment was done for 45 days at 7 and 12°C using temperature-controlled incubator in the laboratories of Horticulture Department and BINA. Bulbs kept in ambient temperature (30 ± 2°C) were considered as control.

Parameters recorded: Periodical harvest of 5 hills was done at 7 days interval and following parameters were recorded very specifically days required to 80% emergence of bulb, percentage of devernalized bulb, plant height, number of green leaves per hill, length of leaves per plants, individual leaf length, fresh weight of leaves, duration of green leaf production, fresh weight of bulbs, fresh weight of roots, number of tillers per hill, number of flower stalks per hill, length of flower stalks per hill, stages of inflorescence development, growth of flower stalk, time of opening the bract, opening of flower in main umbel, number of flowers per umbel, commencement of fruit setting, the stage of ripening of fruits (number of fruit set and percentage of fruit set), the period of seed harvest days required for first visible bolting, growth and maturity of flowering stalk, anthesis period, maturation of fruits and harvesting of dry umbel.

Intercultural operations were done as and when required. The crop was harvested on different dates in different plots when 75% of the tops in each plot had fallen over. Five

hills were randomly selected in each plot to record data on different yield contributing characters and seed yield. Data were statistically analyzed with a computer following MSTAT programme.

RESULTS AND DISCUSSION

The results of the effect of pre-planting cold treatment on the growth and development of onion seed crop with special emphasis on flowering have been presented in Tables (1 & 2). In most of the parameters, pre-planting cold treatment of bulbs at 7°C and 12°C had significantly influenced on growth and leading to flowering towards production of quality seeds of onion (Fig. 1-8).

Among different temperature treatments bulbs treated at 7°C and 12°C emerged quickly than ambient temperature (30 ± 2°C) treated bulbs due to prior vernalization of bulbs. Devernalization of bulbs were observed to be more in case of 7°C temperature treated bulbs where the bulbs were subjected to more cooler condition than 12°C temperature treated bulbs. This might be explained in the way that when the bulbs were planted then absorbed hot temperature from the soil environment, and became devernalized. Thompson (1939) also reported that in some cases vernalized bulb may be devernalized if it from high temperature in field condition. The range of temperature from 21-35°C is favorable and from 28-31°C temperature is more favorable for devernalization of bulbs (Brewster, 1994).

At ambient temperature (30 ± 2°C) plant height, number of leaves and length of leaves were more than 7°C and 12°C temperature treated bulbs, as these bulbs were not so much vernalized, so that, their growth were found to be maximum as like vegetative growth phase. Due to prior vernalization by 7°C and 12°C temperature, treated bulbs produced less plant height, number of leaves and length of leaves, i.e., shortly completed their vegetative growth cycle and started reproductive phase.

Pre-planting cold treatment of bulbs by 7°C and 12°C temperature produced maximum number of tillers and number of flowers than ambient temperature (30 ± 2°C) treated bulbs. This might be due to those bulbs shortly completed their optimum growth stages and enhanced to produce earlier tiller and flower, therefore, the inner small clove of bulbs also came out as tiller, and that is why, more flower stalks were produced.

The flowering and fruiting were delayed due to vigorous growth of plants influenced by the ambient temperature (30 ± 2°C). Therefore, flowers were produced in less number, accordingly their percentage of fruit set were less. On the other hand bulbs vernalized by 7°C and 12°C temperature treated bulbs produced maximum flowering and fruiting due to getting longer time than ambient temperature (30 ± 2°C) treated bulbs. High temperature of 28-30°C during treatment period inhibited inflorescence development *in situ*, but also exerted a marked after-effect in either, prevailing floral initiation during secondary growing season, or greatly reducing flowering (Rabinowitch, 1990).

Table 1. Effect of pre-planting cold treatment on the growth and development of onion seed crops

Treatments	Days required to 80% emergence of bulb	% of devernalized bulb	Plant height (cm)	No. of green leaves/hill	Length of leaves/plant (cm)	Fresh weight of leaves/plant (g)	Fresh weight of bulb/plant (g)
7°C	5.33	11.67	41.00	20.00	31.97	139.80	19.20
12°C	5.00	5.00	39.20	18.10	32.64	141.50	18.80
Ambient temp. (30 ± 2°C)	6.00	0.00	44.33	24.00	35.67	163.80	25.50
LSD at 5%	0.76	-	3.46	-	1.96	-	-
1%	-	2.49	-	3.19	-	11.48	3.63

Table 1. (contd.)

Treatments	Fresh weight of roots/plant (g)	No. of tillers /hill	No. of flower stalks/ hill	Length of flower stalk (cm)	No. of flowers/ umbel	No. of fruits set/umbel	Percentage of fruit set/umbel
7°C	22.50	2.50	2.00	58.33	221.32	136.64	61.00
12°C	25.70	3.00	2.50	56.55	233.35	154.66	66.00
Ambient temp. (30 ± 2°C)	29.60	3.20	2.00	66.44	204.32	101.97	49.00
LSD at 5%	4.94	0.45	NS	-	-	-	11.63
1%	-	-		5.74	18.54	16.95	-

NS = Non significant

Table 2. Days required reaching at different stages of growth cycle of onion seed crop as affected by different temperature treatments

Treatments	Days required to 80% emergence of bulb	Duration of period for green leaves production (DAP)	Days required to first appear flower stalks	Days required for growth and mature of flower stalks after bolting	Days required for bract open from mature flower stalks	Days required for starting flower open from bract open	Days required for flower opening from planting
7°C	5.33	49	30	33	4.33	3	70.33
12°C	5.00	42	28	33	4.33	3	68.33
Ambient temp. (30 ± 2°C)	6.00	49	41	33	5.33	3	82.33
LSD at 5%	0.76	-	-	-	-	-	9.88
1%	-	-	7.82	NS	0.75	NS	-

Table 2. (contd.)

Treatments	Duration of period for opening of total no. of flower	Duration of period for anthesis of flower	Days required for anthesis of flower	Days required for start of fruit setting	Days required for total no. of fruit setting	Days required for maturation of fruits	Days required for harvesting of matured umbel
7°C	29	3	72.33	73.33	29	125	135
12°C	26	3	70.33	71.33	26	124	132
Ambient temp. (30 ± 2°C)	30	3	84.33	85.33	25	137	146
LSD at 5%	NS	NS	9.88	10.47	-	-	8.58
1%			-	-	2.87	9.46	-

NS = Non significant

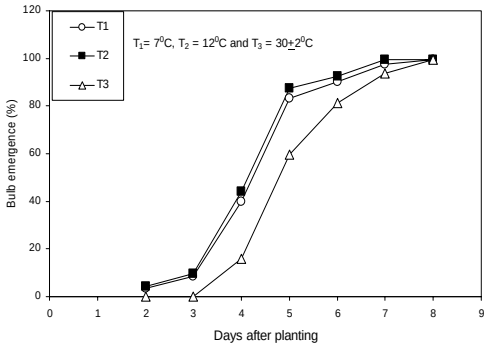

Fig. 1. Effect of pre-planting cold treatment on the percentage of bulb emergence. Vertical bars represent LSD at 5% levels.

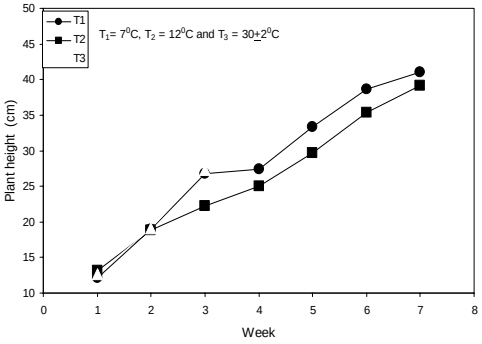

Fig. 2. Effect of pre-planting cold treatment on the plant height of onion. Vertical bars represent LSD at 5% levels.

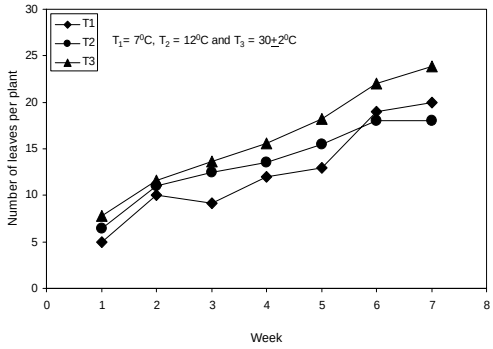

Fig.3. Effect of pre-planting cold treatment on the number of leaves per plant of onion. Vertical bars represent LSD at 5% levels

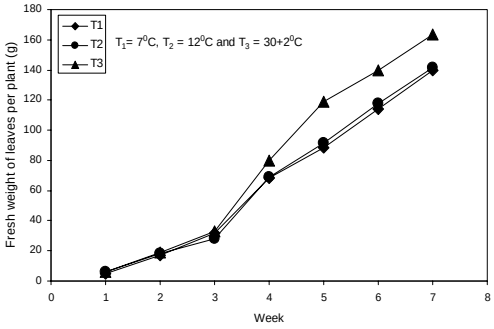

Fig. 4. Effect of pre-planting cold treatment on the fresh weight of leaves per plant of onion. Vertical bars represent LSD at 5% levels.

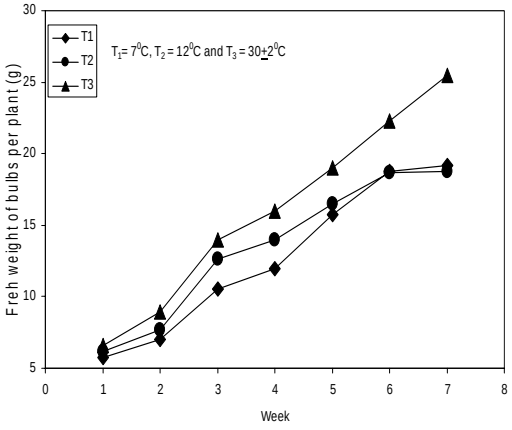

Fig. 5. Effect of pre-planting cold treatment on the fresh weight of bulbs per plant of onion. Vertical bars represent LSD at 5% levels.

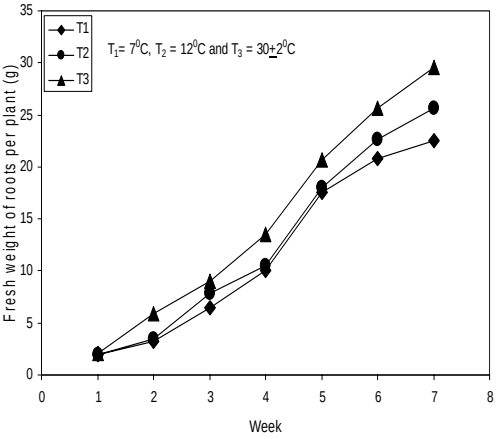

Fig. 6. Effect of pre-planting cold treatment on the fresh weight of roots per plant of onion. Vertical bars represent LSD at 5% levels.

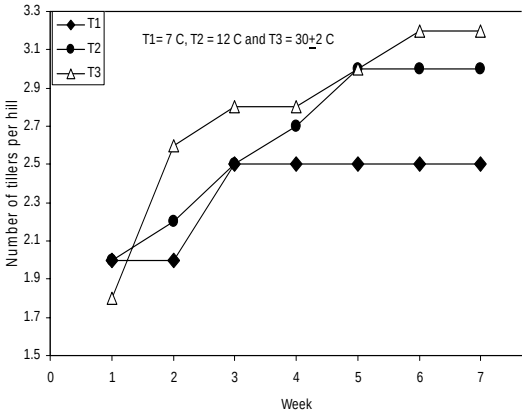

Fig. 7. Effect of pre-planting cold treatment on the number of tillers per hill of onion.

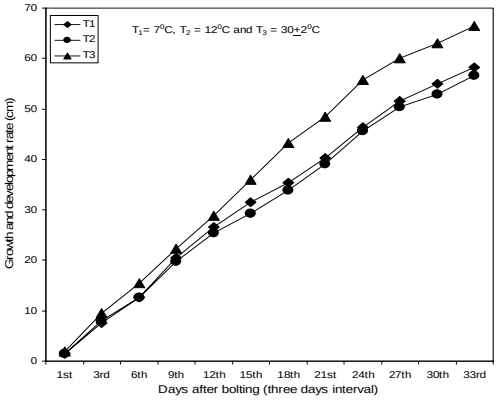

Fig. 8. Effect of pre-planting cold treatment on the growth and development rate (cm) of flower stalks of onion

Days required to 80% emergence of bulb and green leaf production period were faster at 12°C temperature treated bulbs than ambient temperature (30 ± 2°C) treated bulbs, might be due to that 12°C was optimum for pre cooling treatment. Therefore, first visible flowering stalk appeared at 28 days after planting whereas ambient temperature (30 ± 2°C) treated bulbs showed at 41 days. Flowering may be reversibly influenced by high temperature in two ways: by decreasing inflorescence initiation and by promoting bulbing (Brewster, 1994).

Days required for bract opening from mature flower stalk, flower opening from planting, opening of total number of flowers took less time at 7°C and 12°C temperature treated bulbs than ambient temperature (30 ± 2°C) treated bulbs. As a reason, the bulbs got prior optimum vernalization by the temperature treatment. Thompson (1939) reported that sometimes blossoming of flowering might stop even after initiation of flower primordia due to high temperature. Flowering is an essential prerequisite for seed production and its importance is self-evident for higher yield of seed (Brewster, 1994).

Due to higher vegetative growth by the ambient temperature (30 ± 2°C) treated bulbs it took more time than 7°C and 12°C temperature treated bulbs in case of days required for anthesis of flower and starting fruit set. In ambient temperature (30 ± 2°C) treated bulbs, the days required for total number of fruit setting were few, because the late opening flowers could not set fruit properly due to improper vernalization of bulbs. Besides these for getting vernalization by 7°C and 12°C temperature treated bulbs got more time for total number of fruit setting. And for the same reason, maturation of fruits and harvesting of dry umbels took short period than ambient temperature (30 ± 2°C) treated bulbs. Thompson and Smith (1938) found a positive influence of temperature on the rate of development and elongation of flower stalk. They found that low temperature (10 to 15.6°C) under a short day (9 to 12 hrs) onion plants went to seed readily, while under high temperature (21.1 to 26.7°C) they did not go to seed either under a short or under a long 15 hrs day condition.

While comparing between pre-cooling treatment at 7°C and 12°C temperature, the 12°C temperature was found to be better than 7°C temperature, because it took less time in the maximum stages of growth cycle of onion plants. The range of temperature requirement for good vernalization is 2 to 17°C has also been reported by Brewster (1994). Rabinowitch (1990) stated that temperature significantly affects all stages of inflorescences development, its effect can be considered in three ranges: the optimal range, in which inflorescence are induced and developed, the supra optimal range of high temperature, in which very little or no floral initiation takes place, if initiated, the reproductive organ may be hampered or even destroyed, the sub optimal range of low temperatures, at which a longer time is required for initiation and which may be or may not suppress or delayed floral development.

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