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SEED GERMINATION IMPROVEMENT, EMERGENCE UNIFORMITY AND SEEDLING HEALTH IN FLUE-CURED TOBACCO BY DRESSING AND PELLETING

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ABSTRACT

To improve seed germination and seedling emergence of K326 flue-cured tobacco seedlings by disinfection and pelleting, this research was conducted at Tirtash Tobacco Research and Education Center, Behshahr, Iran. Tobacco seeds were pelleted with metalaxyl, thiophanate methyl, imidacloprid, thiomethoxam and thiodicarb and disinfected by heating the seeds in hot air at 60°C for one hour, with hot water at 50°C for 10 minutes and by 0.5% sodium hypochlorite for 4 minutes. The results showed that the lowest percentage of normal seedlings, seedling emergence immediately and one year after seed pelleting and rate of germination coefficient immediately after pelleting, was in case of pelleted seeds with 2 mm diameter. Non-pelleted seeds had the highest germination and seedling emergence did not decrease significantly one year after pelleting. The results of this study showed that all seed disinfection treatments improved germination and seedling emergence percentage in floating seedbed trays and transferable seedlings, also seedlings infected with collar rot, sciaridae fly and aphids were reduced. According to the results of this study, pelleted seeds with 1.5 mm diameter had better germination and seedling emergence.

Keywords: aphid, collar rot, floating seedbed, sciaridae fly, seed storage.

INTRODUCTION

Seed is one of the basic crop production inputs and maximum yield cannot be achieved without the use of high quality seed. Based on the latest statistics of Iran Ministry of Agriculture in 2016-2017 years' tobacco cultivation in the Iran is 10950 hectares and its production has been 21000 tons (Anonymous, 2017). One of the most important stages of tobacco cultivation is the production of healthy and low cost transplants (Clark, 2001). A number of plant pathogens are transmitted outside or inside the seeds, some of which cause serious diseases in the plant (Hamidi, 2018). The soil also contains pathogens that attack the seed and transplant. Therefore, seed disinfection is essential to remove the causative agent from the seed surface and to support transplanting in the early stages of growth (Mallikarjuna and Guru, 2011). Plant diseases such as collar rot, root rot, powdery mildew and plant pests like aphids, crown worms and Sciaridae flies are the most crop yield losses causes in tobacco seedbed which estimated caused about 35% and up to 40% to 80% losses respectively (Barari, 2016). Tobacco aphid (*Myzus nicotianae* blackman) is one of the most important pests of tobacco in reducing the quantity and quality of the product through direct feeding on plants and transmission of important viral diseases. This pest is one of the first pests to be found in most fields up to 100%. *Sclerotinia sclerotiorum*, the causal agent of tobacco collar rot is found in many countries and attacks more than 400 plant species. All commercial tobacco varieties of *N. tabacum* and *N. rustica* are susceptible to this disease and even many wild tobacco species are attacked by this fungus (Shew and Lucas, 1991). The ratio of damage and contamination on other crops such as oilseeds

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legumes and even trees, etc., by the fungus is also extensive (Gayed et al., 1978). *Fusarium* wilts of tobacco is another biotic stress that are scattered all over the world and cause crop damage in tobacco producing countries. Fungi, such as *Fusarium*, is able to infect the seed embryo, sometimes leading to seed rot after planting or seedling death and then the plant debris are colonized by saprophytic fungi such as *Aspergillus*. This fungus invades the seed embryo and cause seed deterioration by the secretion of toxic substances into the cells (Shew and Lucas, 1991).

In the case of tobacco seed because of its small size, pelletized seed is inevitably used for seed transplantation by pneumatic seeders for float system, and tobacco seed producers mainly pelleted tobacco seed to increase its size and to ease planting (Caldeira et al., 2014). However, pelleting can inhibit the germination of tobacco seed and inhibiting the formation of radicals (Nascimento et al., 2009) and delaying the seed germination process by slowing water and oxygen uptake (Franzin et al., 2004). Pelleting the seed may also reduce the light intensity that the tobacco seed should be exposed to during germination, meaning that pelletization reduces the germination of seeds of different plant species that require light to germinate (Santos et al., 2010; Oliveira et al., 2003).

Hashimoto (1961) showed that potassium nitrate, ammonium chloride, ammonium sulfate and ammonium nitrate, with gibberellic acid and kinetin, had a positive effect on increasing germination of tobacco seed. However, these substances alone do not have the effect of increasing the germination of tobacco seed.

Therefore, the use of hormones and other compounds is effective in germination of light-sensitive seeds in the dark. Cui et al. (2012) reported the application of tobacco seed pellets to increase cold tolerance during germination and seedling emergence. Caldeira et al. (2014) observed that pelleting of primed tobacco seeds in different ways improved germination and seedling emergence after three months of storage.

This study was conducted to investigate the effect of pelleting on seed germination and seedling emergence to determine the most appropriate seed size for tobacco seed cultivar K326 to achieve commercial pelletizing technology.

MATERIAL AND METHODS

This study aimed to improve flue-cured tobacco seed germination and seedling emergence through seed disinfection by fungicides and insecticides as seed pelleting. The study were performed at Tirtash Tobacco Research and Education Center in Mazandaran in 2017. In order to isolate the physical impurities, the seeds (the cultivar K326) were first processed by an air flow detector.

Then in accordance to the need of tobacco seed to light for germination, seeds treated by 3% potassium nitrate (KNO_3) solution and during treatment, aerated (Anonymous, 2014). Then, in order to investigate the effect of disinfection on seed germination and seedling emergence, separate experiments were conducted in a completely randomized design with 10 seed disinfection treatments and three replications. Used treatments were: 1 - Control (non-treated); 2 - Metalaxyl 72% wettable powder 2 gr/kg seed + Topsin M 70% wettable powder 2 gr/kg seed + Imidacloprid 5 gr/kg seed; 3 - Metalaxyl 72% wettable powder 2 gr/kg seed + Topsin M 70% wettable powder 2 gr/kg seed + Imidacloprid 5 gr/kg seed + Thiamethoxam 5 cm^3/kg seed; 4 - Metalaxyl 72% wettable powder 2 gr/kg seed + Topsin M 70% wettable powder 2 gr/kg seed + Imidacloprid 5 gr/kg seed + Thiodicarb 4 cm^3/kg seed; 5 - Metalaxyl 72% wettable powder 2.5 gr/kg seed + Topsin M 70% wettable powder 2.5 gr/kg seed + Imidacloprid 10 gr/kg seed; 6 - Metalaxyl 72% wettable powder 2.5 gr/kg seed + Topsin M 70% wettable powder 2.5 gr/kg seed + Imidacloprid 10 gr/kg seed + Thiodicarb 6 cm^3/kg seed; 7 - Thiamethoxam 5 cm^3/kg seed; 8 - Seed heating at 60°C for one hour; 9 - Seed treatment by warm water at 50°C for 10 minutes; 10 - Seed disinfection by sodium hypochlorite 0.5% for 4 minutes.

The main constituents of seed coatings for pelleting include:

1 - inner layer: 15-25 percent of pellet weight, low nutrient content, nitrogen and potassium nitrate (in a solution of 3-5 g/L), pellet degradation material and calcium carbonate.

2 - layer intermediate: containing 65-75 percent of pellet weight of kaolin, clay, vermiculite, talc, sawdust, lactose, calcium silicate and bentonite.

3 - outer layer: 5-10 percent of pellet weight included graphite materials, Arabic gum, starch, cellulose methyl, harmless dyes and disinfectants used in this study.

The constituents of the pellets usually disappear gradually after 2 to 5 years due to microbial decomposition and sunlight and become substances such as water, carbon dioxide and ammonium do no harm to nature. Seed disinfection by pelleting using a pelletizer (Rotating boiler) equipped with spray nozzles based on Zamani et al. (2018) formula for seeds disinfecting with pelleting the above-mentioned pesticides and spray was performed.

Normal seedlings percent immediately after seeds pelleting, coefficient of velocity of germination immediately after seeds pelleting, normal seedlings percent one year after seeds pelleting were measured by tobacco standard germination test conduction, seedling emergence in nursery immediately after seeds pelleting, seedling emergence in nursery one year after seeds pelleting by Planting 400 seeds to 4 repeat in 9 cm Petri on a Whitman No. 1 Filter and water was added and placed in a germinator for 16 days at alternating temperatures of 20 and 30°C (16 and 8 hours, respectively) (Anonymous, 2018). Normal seedlings were then determined according to International Seed Testing Association criteria (Anonymous, 2014).

The studied traits were ratio of normal seedlings, emergence in floating seedbed tray, transferable transplant, infected seedlings to tobacco aphids, of damaged seedlings by sciaridae fly, and infected seedlings to collar rot, percentage of normal seedlings, standard germination test.

To determine seedling emergence percentage in floating seedbed tray, 100 seeds of each treatment with four replications in floating seedbed trays made of polystyrene (Styrofoam) with pyramidal (cell trays) containing culture medium include peat moss 50% + vermiculite 25% + sterile field soil 25% (Siavash Moghaddam et al., 2017) were planted in open pits by dibbler on the culture medium. Percentage of seedlings emerged 16 days after sowing was calculated. At the end of the seedbed period and at the time of transplant readiness to be transferred to the farm, the percentage of transferable transplant was calculated. During the storage of transplants in the floating seedbed, the percentage of transplants infected under natural contamination with tobacco aphids was evaluated to investigate the effect of different treatments on tobacco aphid control. In order to investigate the effect of different treatments on control of Sciaridae fly in floating seedbed, the percentage of infected transplants was determined. In order to investigate the effect of different treatments on the control of collar rot (*Sclerotinia sclerotiorum*) in the floating seedbed, in this experiment, inoculation of floating seedbed trays by artificial Inoculation was done and 7 mm diameter mycelium discs from fresh fungal culture (ten discs per plot) on the main leaf vein, at near the crown of one-month-old and susceptible seedlings were transferred.

Identification of seed-associated fungi was also designed to investigate the effect of different treatments on experimental seed-associated fungi in Petri by placing 100 seeds in each treatment in three replications per petri to determine the effect of treatments on the associated fungi and also identification of fungi associated with each specimen were carried out by transferring to PDA medium and identification of fungi at genus and species level. In addition to the aforementioned evaluations, fungal agents with non-disinfected seeds (control treatment) were first examined and also disinfected treatments were performed by evaluating all seed germinated tobacco seeds in standard germination test and fungal growth was not observed in disinfected

treatments, but some seed-associated fungi including *Aspergillus flavus, A. fumigates, A. niger, Fusarium solani, F. oxysporum* and *Alternaria* alternate were identified in untreated seeds. Seeds were then stored in the cold storage at 10°C for one year to evaluate their shelf-life.

Standard germination test to determine seed germination percentage immediately after pelleting and after one year of storage in cold storage, by planting each experimental unit 100 seeds in 9 cm diameter petris each containing a layer of Whatman No. 1 round paper. The experiments were performed with 4 replicates and placed in germinator for 16 days at alternating temperatures of 20 and 30°C (8 and 16 hours, respectively) and 16 hours of illumination (2500 lux) and 8 hours of darkness (Anonymous, 2014). To determine the germination rate coefficient of seeds immediately after pelleting, daily recording of the number of germinated seeds per petri until day 12 was calculated using a correlation.

$$\text{Eq. 1:} \quad CVG = G1 + G2 + ... + Gn / (1 \times G1) + (2 \times G2) + ... + (n \times Gn)$$

where:

G1 - Gn is the number of germinated seeds from day 1 to the end of the test (Ranal and De Santana, 2006). On the twelfth day, normal seedlings were counted and evaluated, and the percentage of normal seedlings was calculated from the relationship of No. 2 (Anonymous, 2013).

$$\text{Eq. 2:} \quad (\text{number of twelfth day seedlings/total number of seeds per petri}) \times 100 = \text{percentage of seedlings}$$

In order to investigate seedling emergence in the seedbed, immediately after pelleting and after one year of storage in the cold storage, 44 seeds per treatment with 4 replications on floated culture tray, each tray with 220 holes (33 × 57 × 4 cm) of polystyrene were planted with pit soil using seed seeding apparatus.

Then, the trays cultured on pods containing 25 liters of water were disinfected with Copper Oxychloride 35% (Cupravit, wettable powder 35%) and 0.9 g per tray Metalaxyl (Ridomil Mancozeb, wettable powder 72%). Nutrients in the first stage include 12 grams the total fertilizer, was evaluated in the second stage only with 7 grams of ammonium nitrate per tray in the laboratory greenhouse.

Normal seedlings percent the data were analyzed using MSTAT-C software and the means were compared with Duncan's test at 0.05.

RESULTS AND DISCUSSION

Seed disinfection

Analysis of variance showed that the percentage of normal seedlings did not affected significantly by the seed disinfection treatments, but the effect of these treatments was significant at 1% probability level for the other studied traits (Table 1).

Table 1. Analysis of variance (mean squares) of normal seedlings, seedling emergence and transplantable seedling percent and studied pests and disease infection disease infection

Source of variance	df	(MS)					
		Normal seedlings (%)	Seedling emergence in float trays (%)	Transplantable seedlings (%)	Seedlings infected by aphid (%)	Seedlings infected by sciaridae fly (%)	Seedlings infected by stem rot (%)
Seed treatment	9	21.80^{ns}	657.20**	750.80**	1080.0**	1893.90**	37030**
Error	20	14.40	23.00	32.00	20.80	25.1	19.10
C.V. (%)		4.11	6.90	8.80	18.75	12.85	17.70

^{ns} and ** non-significant and significant at 1% probability.

Evaluation of the effect of different treatments on the percentage of seedlings infected by aphids, sciaridae fly and collar rot showed that untreated seeds showed the most contamination with these pests and diseases and seed treatment with 2.5 g/kg Metalaxyl +

2.5 g/kg Topsin M + 10 g/kg Imidacloprid insecticide + 6 ml/kg Thiodicarb insecticide caused the greatest reduction in their contamination (Table 2). Therefore, treatment of the seeds with this combination of fungicides and insecticides had the greatest effect on reducing aphid, sciaridae fly and collar rot, and caused the highest percentage of normal seedlings, seedlings appearance in floating trays and portable transplants (Figures 1 and 2). Babadoost and Islam (2003) reported a decrease in *Phytophthora* wilt caused by *Ph. capsici* of Pumpkin seedlings in greenhouse due to treatment with Metalaxyl. Zhang et al. (2011) observed that the disinfection of cotton seeds with thiamethoxam and imidacloprid reduced whitefly populations.

Although the difference between the percentages of normal seedlings in different seed disinfection treatments was not significant, comparing the means showed that the seed treatments increased the percentage of normal seedlings (Table 2). These results indicated that seed treatment with 2.5 g/kg seed Metalaxyl + 2.5 g/kg seed + 10 g/kg seed Imidacloprid + 6 cm^3/kg seed of Thiodicarb, as well as treatment with 5 ml/kg seed Thiomethoxam, produced the most normal seedlings. Haghanifar et al. (2018) reported improved germination of single cross-704 hybrid maize seeds by imidacloprid and Tebuconazole fungicides. Tamindžić et al. (2016a, b) investigated the effect of maize (inbred) lines seeds treatment by Metalaxyl, Imidacloprid and Thiamethoxam on normal seedlings improvement.

Untreated seeds had the lowest percentage of seedling emergence in float seedbed trays and seeds treated with 2.5 g/kg of Metalaxyl + 2.5 g/kg Topsin M + 10 g/kg Imidacloprid + 6 ml/kg of Thiodicarb also had the highest percentage of seedling emergence in the floating nursery trays (Table 2). Smiley et al. (1996) investigated wheat seedlings emergence in field improvement thought seed treatment by fungicides. Abati et al. (2014) also observed the seed treatments with Carboxin + Thiram + Imidacloprid + Thiodicarb, and Carbendazim + Thiram + Imidacloprid + Thiodicarb improve seedling establishment in the field compared to the control.

Seeds without any treatment (control) and seed treatment with 2.5 g/kg seed Metalaxyl + 2.5 g/kg seed Topsin M + 10 g/kg seed Imidacloprid insecticide + 6 ml/kg seed Thiodicarb had the highest transplantable seedlings percent (Table 2). Chanprasert et al. (2012) reported that disinfection of oil palm seeds with Imidacloprid and Thiamethoxam did not increase germination percentage, time required to reach 50% seed germination and root length and seed treatment with Imidacloprid increased shoot growth and seedling vigor. Taye et al. (2013) reported that Metalaxyl had the most beneficial effect on corn seed germination and seedling growth.

Table 2. Mean comparisons of studied seed treatments on seedling percent and infection to pests and collar rot

Seed dressing treatment	Normal seedlings (%)	Seedling emergence in float trays (%)	Transplantable seedlings (%)	Seedlings infected by aphid (%)	Seedlings infected by sciaridae fly (%)	Seedlings infected by collar rot (%)
1†	89.16a	52.0d	54.0d	53.3a	84.3a	42.0a
2	93.1a	75.0c	73.0c	15.0d	28.6e	28.3bcd
3	92.8a	82.0ab	80.0ab	6.6de	22.0ef	25.3cd
4	94.6a	75.3bc	71.0bc	11.6d	21.6ef	21.6d
5	91.3a	81.0abc	77.0abc	15.0d	19.0f	10.0e
6	96.56a	85.0a	83.0a	1.6e	14.6g	9.0e
7	96.2a	80.0abc	76.0abc	11.6d	19.0f	12.6e
8	90.86a	65.0d	59.3d	46.6ab	50.3d	30.3bc
9	91.22a	58.3d	45.0d	36.6c	60.0c	35.0ab
10	95.98a	54.0d	46.0d	45.0b	69.6b	31.3bc

* Means having at least one same letter had not significant difference.

†1 - Control (non-treated);
2 - Metalaxyl 72% wettable powder 2 gr/kg seed + Topsin M 70% wettable powder 2 g/kg seed + Imidacloprid 5 gr/kg seed;
3 - Metalaxyl 72% wettable powder 2 g/kg seed + Topsin M 70% wettable powder 2 g/kg seed + Imidacloprid 5 gr/kg seed + Thiamethoxam 5 cm^3/kg seed;
4 - Metalaxyl 72% wettable powder 2 g/kg seed + Topsin M 70% wettable powder 2 g/kg seed + Imidacloprid 5 gr/kg seed + Thiodicarb 4cm^3/kg seed;
5 - Metalaxyl 72% wettable powder 2.5 g/kg seed + Topsin M 70% wettable powder 2.5 g/kg seed + Imidacloprid 10 gr/kg seed;
6 - Metalaxyl 72% wettable powder 2.5 g/kg seed + Topsin M 70% wettable powder 2.5 g/kg seed + Imidacloprid 10 gr/kg seed + Thiodicarb 6 cm^3/kg seed;
7 - Thiamethoxam 5 cm^3/kg seed;
8 - Seed heating at 60°C during 1 hour;
9 - Seed treatment by warm water at 50°C during 10 minutes;
10 - Seed disinfection by sodium hypochlorite 0.5% during 4 minutes.

Figure 1. Comparisons of control treatment had high infection by aphids (right) and seed dressing treatment had low infection by aphids (left)

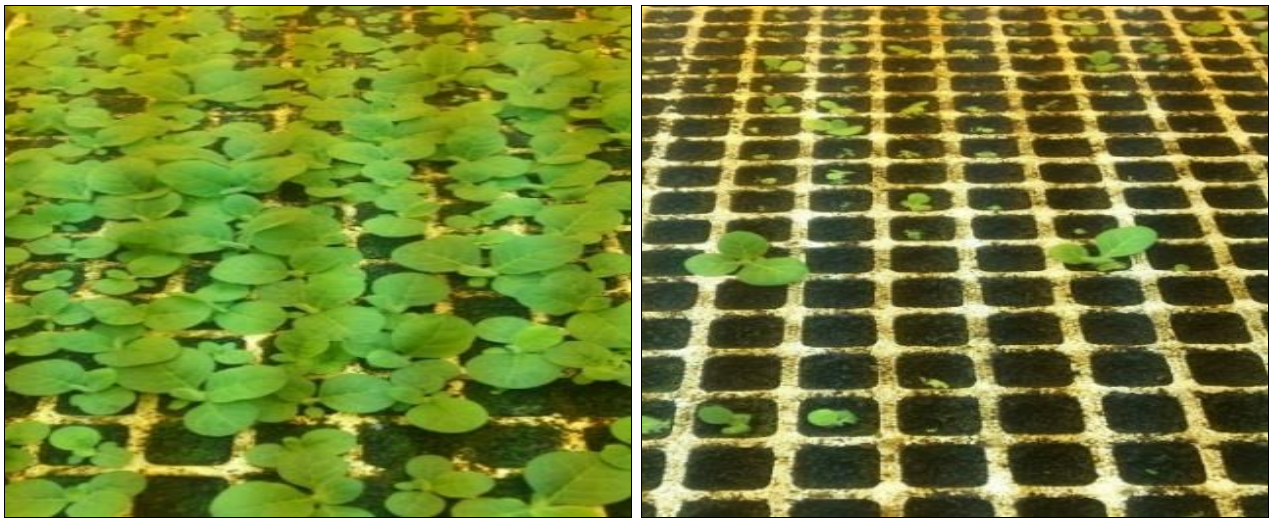

Figure 2. Comparisons of low transplantable seedlings percent of control treatment had high infection by Sciaridae fly (right) with high transplantable seedlings percent of superior seed dressing treatment (left)

Shakir et al. (2016) also observed that treatment with low concentrations of different pesticides such as Imidacloprid improved tomato seed germination and seedling growth but seed germination and seedling growth decreased with increasing pesticide concentration. Ding et al. (2018) investigated the effect of corn seed treatment

with Neonicotinoid insecticides such as Imidacloprid and Thiamethoxam on trips seedling control while studying effect of this treatment on seedling growth characteristics and proper control of pest population achieved, by seed treatment with thiamethoxam which also improved seedling growth characteristics. Addison and Fischer (2002) claimed that by treating forage rapeseed seeds with imidacloprid at the rate of 1.75 to 21 g/kg, showed no negative effect on seed germination and seedling growth.

Seed pelleting

Analysis of variance showed that normal seedlings percent immediately after seeds pelleting, coefficient of velocity of germination immediately after seeds pelleting and seedling emergence percentage in the seedbed one year after pelleting were significantly (P≥1%) affected by the treatments, however, normal seedlings percent one year after seeds pelleting and seedling emergence in nursery one year after seeds pelleting were not affected by the treatments (Table 3). Hartley et al. (2002) reported increasing percentages and synchrony of germination and decreasing the time required to germinate 90% of priming tobacco seeds. Kasperbauer (1968) for the first time observed that the sensitivity to light of germination of a tobacco seed was temperature dependent reaction.

Table 3. Analysis of variance (mean squares) of tobacco pelleted seeds various sizes and not pelleted seeds

Source of variance	df	(MS)				
		Normal seedlings immediately after seeds pelleting (%)	Coefficient of velocity of germination immediately after seeds pelleting	Normal seedlings one year after seeds pelleting (%)	Seedling emergence in nursery immediately after seeds pelleting (%)	Seedling emergence in nursery one year after seeds pelleting (%)
Treatment	4	1161**	358**	40^{ns}	606**	14^{ns}
Error	15	46	51	25	93	30
Coefficient of variation (%)		8	7	5	11	6

^{ns} and **non-significant and significant at 1 percent probability, respectively.

The results of means comparison showed that pelleted seeds with 2 mm diameter had the lowest percentage of normal seedlings, germination rate coefficient of seedling emergence percentage in seedbed immediately after pelleting and the highest values were obtained for these traits and for the unpelleted seeds (Table 4). Therefore, the effect of treatments on percentage of normal seedling and seedling emergence percentage in seedbed one year after seed pelleting may not be significant due to seed deterioration and relative reduction of seed treatment advantage.

Table 4. Mean comparisons of seed germination and seedling emergence traits of various treatments

Treatment	Normal seedlings percent immediately after seeds pelleting	Coefficient of velocity of germination immediately after seeds pelleting	Seedling emergence in nursery immediately after seeds pelleting
Not pelleted (crud) seed	96a*	98a	91a
1 mm diameter pelleted seed	89a	99a	86a
1.5 mm diameter pelleted seed	92a	94a	86a
2 mm diameter pelleted seed	54b	77b	60b
Pelleted seed in foreign country	90a	98a	81a

* Means having at least one same letter had not significant difference.

Given the higher sensitivity of light to germination of tobacco seeds and the observed higher germination rate of light-exposed tobacco seeds (Hartley et al., 2002), it seems that the higher percentage of normal seedlings of non-pelleted seeds was due to more exposed to light, as compared to pelleted seeds. Photodormancy of tobacco seeds occurs mainly when the seed is harvested without being sufficiently dried (Hutchens, 1999). Seed storage under suitable conditions for several months usually eliminates this type of photodormancy (Hutchens, 1999; Steinberg, 1960). Toole (1975) showed that seed germination of some species of photodormancy increased with exposure to light and constant or dark temperatures and alternating day and night temperatures that mimic the periodic fluctuation of the corresponding natural temperature.

The results also showed that by increasing the pelleted seed diameter, normal seedlings percentage, the germination rate coefficient, seedling emergence percentage in seedbed decreased immediately after pelleting (Table 2). Caldeira et al. (2014) reported a decrease in the percentage and rate of germination of tobacco seeds after pelleting. They also observed that germination rate of pelleted and non-pelleted tobacco seeds did not change significantly at 1, 2 and 3 months after storage at 10°C and 50% relative humidity. Caldeira et al. (2016) stored pelleted tobacco seeds for 6 and 12 months at 10°C and relative humidity of 50% and observed that the final germination percentage of the seeds was significantly not affected by the pellet, but the germination process slowed. Seeds also retained their germination ability during storage. However, Bertagnolli et al. (2003) showed that the pelleted lettuce seeds were more tolerant to heat stress than the unpelleted lettuce seeds.

According to the results of this study, decrease in percentage of normal seedlings, germination rate coefficient and seedling emergence percentage in seedbed immediately after pelleting, especially in 2 mm diameter pelleted seeds, can be due to reduction effect of light permeation required for germination, as well as no timely degradation of the compounds used for pelleting and thus preventing these materials from receiving sufficient environmental factors needed for germination. Adequate and timely destruction of materials used for seed pelleting by water absorption and environmental factors after planting is of great importance for timely and uniform germination and emergence of tobacco (Caruso et al., 2000).

CONCLUSIONS

The results showed that the tobacco seeds (K326 cultivar) disinfected with 2.5 g/kg seed Metalaxyl + 2.5 g/kg seed Thiophanate-methyl (70% wetable powder) + 10 g/kg seed Imidacloprid + 6 ml/kg seed Thiodicarb insecticide, have the highest percentages of normal seedlings, seedlings emerged in floating seedbed trays and portable transplants and the lowest seedlings contaminated with sciaridae fly, aphids and collar rot. The traits of seed treatment with the studied fungicides and insecticides were superior as compared with those of seeds non treated. Due to the use of seed disinfectant formulations of plant growth regulators that stimulate germination, the seed germination and seedling emergence will be improved.

The results also showed that seed germination ability and rate, and seedling emergence in K326 flue-cured tobacco compartment decreased with increasing seed surroundings for pelletization and seed germination properties were not affected by seed storage. Also, considering the percentage of normal seedlings, more pelleted seeds with a diameter of 1.5 mm, it is recommended to pellet the flue-cured tobacco seeds of cultivar K326 with a maximum diameter of 1.5 mm.

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