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Research Article

EFFECT OF DIFFERENT POLLINATOR ATTRACTANT CROPS FOR SEED SETTING AND MAXIMIZING SEED YIELD OF ONION

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Abstract

The experiment was conducted at the Spices Research Centre, Shibgonj, Bogra during rabi season, 2010-11and 2011-12 to identify the suitable pollinator attractant crops for increasing the vigilance of pollinators and higher seed settings and thereby increasing seed yield of onion. In 2010-11, the highest seed setting was recorded in onion + fennel (69.88%) which was statistically identical to Onion + coriander (67.45 %) and Onion + black cumin (64.15 %) while the highest seed setting was recorded in Onion + Fennel (73.70 %) which was identical to Onion + Dill (70.50%) and Onion + Coriander(72.37%) during 2011-12. In 2010-11, the highest seed yield (865.5 kg/ha) was obtained from Onion + fennel which was identical to Onion + coriander (838.1 kg/ha) but in 2011-12, the highest seed yield (1165.34 kg/ha) was recorded from Onion + fennel which was identical to Onion + coriander (1064.59 kg/ha). In both the years, percent seed setting was lowest in Sole onion (55.93 % in 2010-11and 57.73% in 2011-12). Accordingly, the lowest seed yield was also recorded from Sole onion (623.3 kg/ha in 2010-11 and 685.44 kg/ha in 2011-12). Dill and Fennel was the better attractant crop for pollination while coriander acted as intermediate.

Keywords: Pollinator; Attractant Crops; Seed Yield; onion.

Introduction

Onion is an important spice crop in Bangladesh. The average world production of onion (Bulb) is 15 t/ha and in Bangladesh it is only 7.1 t/ha (BBS, 2013). The total production of onion in Bangladesh is only 8.89 lakh metric tons as against the estimated demand of 15.75 lakh metric tons (BBS, 2013). It is possible to meet up the demand by increasing per unit yield through supplying quality seeds or by bringing more area under onion cultivation. Onion (Allium cepaL.) is an entomophilous crop. It requires cross pollination for seed setting due to its protandrous flowers character (Patil *et al.*, 2011; Muller, 1983). Single umbel flowers of the onion inflorescence are not capable of self-pollination. The pollen must come from another flower of the same or different plant for its pollination (Wilkaniec *et al.*, 2004). So, pollinator plays a vital role for quality seed production and increased seed yield. But the vigilance of pollinators is not enough in onion field for more fertilization as well as for quality seed production. Also, onion does not produce quality seed in the absence of available pollinators (Chandel *et al*., 2004). In northern region of Bangladesh, the seed production is badly hampered due lack of sufficient vigilance of pollinators. Different types of insect visits the onion flower for pollination especially the honey bees, flies, butterflies, beetles. Acute deficit of natural pollinators is one of the main reasons of low onion seed yields (Witter and Blochtein, 2003). The availability of the natural insect pollinators is decreasing due to some factors such as indiscriminate use of pesticides and decline in natural habitats to some extent (Saeed *et al.*, 2008). Farmers now have to import/ raise pollinators to ensure good production of their crops (CWF, 2008). It is also possible in some situation to encourage the vigilance of different pollinators by distributing suitable pollinator attractants border crop like Fennel, Dill & Black cumin, fruit juice (mango, jackfruit etc) or dried fish surrounding/within the flowering crop (Currah and Proctor, 1990). Coriander, Fennel and black cumin may be good attractant for increasing the vigilance of pollinators because their flower colour and smell is attractive, which encourage the vigilance of the pollinators. There is enough scope to use these crops as boarder or intercrop for increasing the vigilance of different pollinators. In Bangladesh, little work has been made in this regard. With this view, the present study has been aimed to identify suitable attractant crop for increasing vigilance of pollinators for higher seed yield of onion.

Materials and Methods

The experiment was conducted at the Spices Research Centre, Shibgonj, Bogra during rabi season, 2010-11 and 2011-12 to identify suitable attractant crops for increasing the vigilance of pollinators for higher seed setting and

thereby increasing seed yield of onion. The land was medium high and the soil was clay loam in texture. The experiment was laid out in randomized complete block design with three dispersed replications. The distance among replications varied from 500m to 600m. In 2010-11, four treatments viz., Onion + Fennel (two rows at every 10 rows of onion including border), Onion + Black cumin (two rows at every 10 rows of onion including border), Onion + Coriander (two rows at every 10 rows of onion including border) and Sole onion were compared to achieve the objectives. In 2011-12, the treatment Onion + Black cumin was discarded and onion + Dill was included along with other treatments. The unit plot size was 11.8 x 8 m^2 in 2010-2011 and 7.2 x6 m^2 in 2011-12. In each plot, BARI Piaz-4 was planted maintaining 20 cm x 15 cm spacing. As per treatments, the boarder crop was planted in paired rows, maintaining 30 cm x 15 cm, 30cm x15cm, 20 cm x 15 cm and 30 cm x 15 cm spacing for Fennel (Advance line), Dill (Advance line), Black cumin (BARI Kalizira 1) and Coriander (BARI coriander 1), respectively. The crop (onion) was planted through 13-14 November 2010 and 13-15 in November 2011. The border crop was planted few days later than that of onion planting. In 2010-11, Fennel was sown on the day of onion planting, Black cumin was sown on 16 days later than onion planting and Coriander was sown on 15 days later than onion planting. In 2011-12, Fennel and Dill was planted on the day of onion planting, and Coriander was sown on 4 December (20days later than onion planting). In addition to 5 t/ha of cow dung, the crop was fertilized with N_{145} P_{83} K_{84} S_{20} Zn_3 B_2 kg/ha. The entire amount of cow dung P, S, Zn, B, ¼N and 1/3 K was applied during final land preparation. The rest N was applied in three equal splits at 40, 60 and 80 days after planting (DAP) in both the years.. The rest K was applied in two equal splits at 40 and 60 DAP. No additional fertilizer was used for boarder crops. To control purple blotch disease, the crop was sprayed with 'Rovral' @ 2g /L of water at 40, 50, 60 and 70 DAP in both the years. Similarly, to control thrips, 'Gain' @ 0.25 ml/L of water was sprayed at 35, 45, 55 and 65 DAP. The spray remained stopped after initiation of first blooming**.** One observer was assigned to each replication and observations were synchronized to run through 10.00 to 11.24. Therefore, each observer walked down 28 minutes for each treatment. An insect landing on an open umbel was considered to be a 'visit'. The observation started from 6 February to 3 April in both the years. The observers rotated to different replications in alternate day in a cyclic order. A nearly similar observation technique was also used by Ellis and Delaplane (2009). Starting and finishing of counting was done at the same time. The visit was counted by eye estimation. Data on plant height, scape height, number of umbel per plant, diameter of umbel, number of flowers per umbel, number of flowers setting seeds per umbel, percent seed settings, 1000-seed weight, seed yield, types of pollinator and number of vigilance were recorded. Except vigilance, all other data were analyzed and mean separation was done by DMRT following MSTAT software.

Results and Discussion

Vigilance on Attractant Crops

Attractant crops were sown in onion field to enhance pollination in onion. The daily patterns of visits of different insect pollinators are shown in Fig. 1 to Fig. 14.

Horse Fly

The impact of Horse fly on pollination was more important. The visit of horse fly (*Tabanus spp.*) was more in fennel followed by coriander and black cumin. In 2010-11, the peak visit was on 20 March (875 visit) in fennel, 25 February (685 visits) in coriander and 12 March (495 visits) in black cumin (Fig. 1). In 2011-12, the peak visit was on 17 March (890 visit) in Dill, 19 March (862 visits) in fennel and 3 March (678 visits) in coriander (Fig. 2).

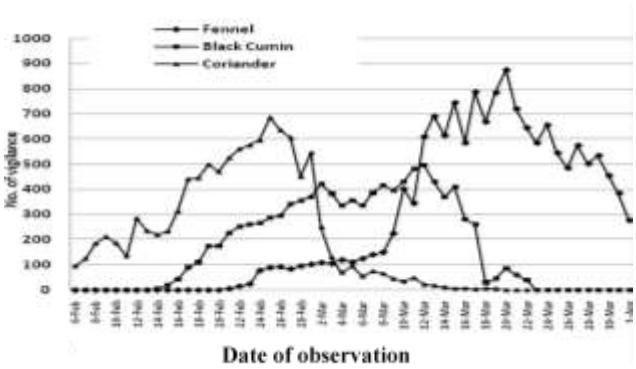


Fig. 1: Vigilance of Horsefly on attractant crops, 2010-11

Fig. 2: Vigilance of Horsefly on attractant crops, 2011-12

Honey Bee

Marked influence of Honey bees (*Apis spp.)* were found as an insect pollinator during crop production. It was the second most important insect pollinators recorded in our study. The crop fennel and Dill attracted more honey bees compared to other crops. The coriander attracts intermediately. In 2010-11, the peak visit was recorded on 19 March in fennel (165 visits), 24 February in coriander (148 visits) and 11 March in black cumin (137 visits) (Fig. 3). In 2011-12, the peak visit was recorded on 17 March in

Dill (186 visits), 21 March in fennel (178 visits) and 6 March in coriander (155 visits) (Fig. 4).

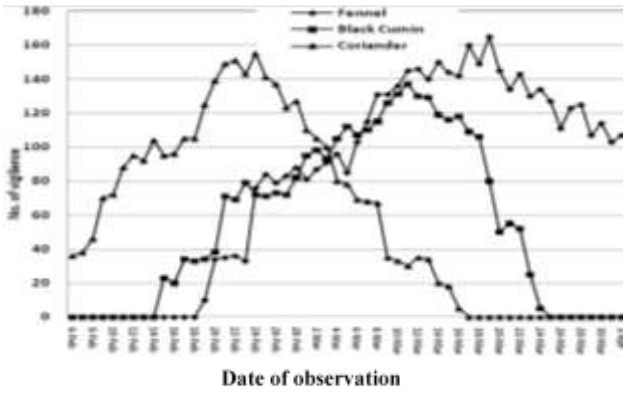


Fig. 3: Vigilance of Honey bee on attractant crops, 2010-11

Fig. 4: Vigilance of Honey bee on attractant crops, 2011-12

Syrphid Fly (Helophilus spp.)

Marked impact of Syrphid flies **(***Helophilus spp.***)** were observed as an insect pollinator in attractant crops. It was the third most insect pollinator for pollination. In 2010-11, the peak visit was recorded on 20 March in fennel (26 visits), 27 February in coriander (22 visits) and 13 March in black cumin (18 visits) (Fig. 5). Similarly in 2011-12, the peak visit was recorded on 20 March in Dill (66 visits), 22 March in fennel (58 visits) and 4 March in coriander (52 visits) (Fig. 6).

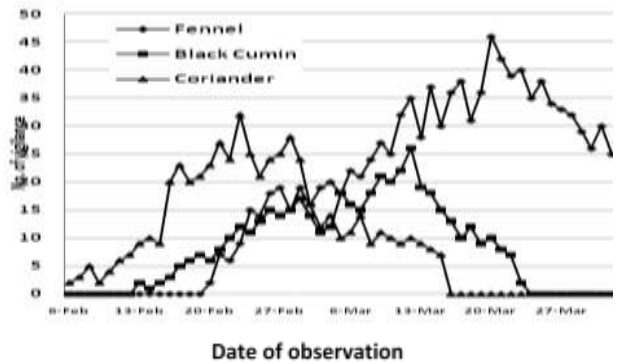


Fig. 5: Vigilance of Syrphid fly on attractant crops, 2010-11.

Fig. 6: Vigilance of Syrphid fly on attractant crops, 2011-12.

Blow Fly (Phormia regina)

In 2010-11, the Blow fly extended peak visits on 22 March (26 visits) in fennel followed by coriander (22 visits on 27 February) and black cumin (18 visits on 13 March) (Fig. 7). In 2011-12, the peak visit was recorded on 19 March in Dill (25visits), 24 March in fennel (22 visits) and 8 March in coriander (16 visits) (Fig. 8). The potentiality of this insect could not be ignored for pollination.

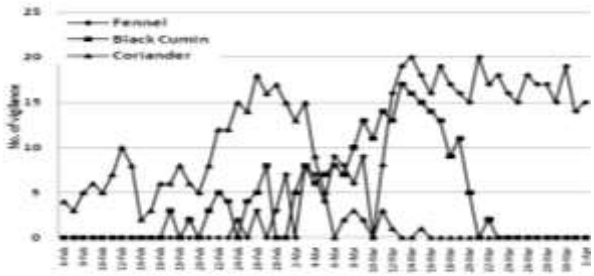
Fig. 7: Vigilance of Blow fly on attractant crops, 2010-11.

Fig. 8: Vigilance of Blow fly on attractant crops, 2011-12.

House Fly (Musca domestica)

The potentiality of House fly was low as a pollinator, however, its contribution could not be underestimated. In 2010-11, the peak visit was recorded on 21 March in fennel (20 visits), 26 February in coriander (18 visits) and 13

March in black cumin (17 visits) (Fig. 9). In 2011-12, the peak visit was recorded on 20 March in Dill (21 visits), 23 March in fennel (18 visits) and 6 March in coriander (17 visits) (Fig. 10).



Date of observation

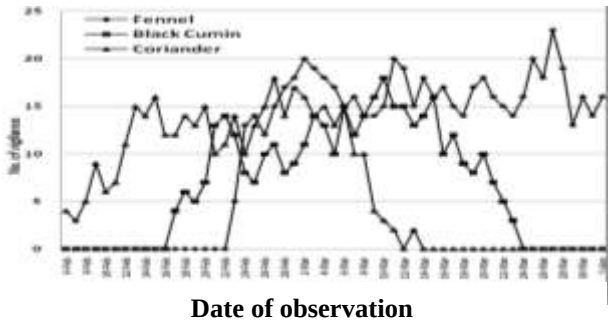
Fig. 9: Vigilance of house fly on attractant crops, 2010-11.

Date of observation

Fig. 10: Vigilance of house fly on attractant crops, 2011-12.

Other Insects

Other insect that visited attractant crops for pollination was Bumble bees, Paper wasp, Yellow jacket (*Vespula spp.*), Butter flies etc considered as minor insect pollinator (Fig. 11&12). Irrespective of all insect, Dill attracted more Horse fly, Honey bees, Syrphid flies and other insects which was closely followed by fennel. (Fig. 13&14). Coriander attracted intermediately. The attraction of insect to black cumin was the lowest. So, it was evident that fennel was the best attractant crop for pollination in 2010-11 and both Dill and fennel was the best attractant crop for pollination in 2011-12. However, coriander is the second best. The performance of Black Cumin was not satisfactory.



Date of observation

Fig. 11: Vigilance of other insects on attractant crops, 2010-11.

Date of observation

Fig. 12: Vigilance of other insects on attractant crops, 2011-12

Date of observation

Fig. 13: Mean vigilance of different insect on attractant crops, 20110-11.

Date of observation

Fig. 14: Mean vigilance of different insect on attractant crops, 2011-12.

Yield and Other Parameters

The yield and yield contributing characters of onion as affected by different treatments are presented in Table 1&2. In both years, the number of seeds setting per umbel, percent seed settings, and seed yield were significantly affected by different treatments while other parameters were not significant.

Different attractants had no significant effects on plant height of onion. However, in 2010-11, the tallest plant was recorded from Sole onion (93.13 cm), which was followed by Onion + Fennel (92.20cm), and Onion + Coriander (91.27 cm) (Table 1). Similarly, the tallest plant was recorded from onion + Dill (105.27cm) which was followed by Onion + Fennel (103.55cm), Sole onion (99.00 cm) and , Onion + Coriander (98.67cm) in 2011-12 (Table 2).

Table 1: Effect of different crops as pollinator attractant on seed yield and yield contributing characters of onion during Rabi season, 2010-2011.

Treatments	Plant height (cm)	Scape height (cm)	Number of umbels/plant	Diameter of umbel (cm)	Number of flowers/umbel	Number of seed settings/ umbel	Seed settings/ umbel (%)	1000-grain (g)	Seed yield (kg/ha)
T_1= Onion + Fennel	91.27a	89.71a	3.33a	7.82a	523.3a	363.7a	69.88a	3.04a	865.5a
T_2=Onion + Black Cumin	90.66a	86.73a	3.66a	7.66a	516.3a	330.7b	64.15ab	3.00a	809.4b
T_3= Onion + Coriander	92.20a	88.59a	3.33a	7.52a	518.3a	346.7ab	67.45a	3.02a	838.1 ab
T_4= Control*	93.13a	87.50a	3.00a	7.71a	528.0a	295.3c	55.93b	3.01a	623.3c
Level of significance	NS	NS	NS	NS	NS	**	*	NS	**
CV (%)	8.45	8.87	14.14	2.06	5.86	3.49	7.09	5.71	3.25

In a column, means followed by the same letters did not differ significantly at 5% levels of probability. *Control (without attractants crop), Mean plant population:$T_{1=243500/ha,}$ $T_{2=242050,}$ $T_{3=243000,}$ $T_{4=245250}$

Table-2: Effect of different crops as pollinator attractant on seed yield and yield contributing characters of onion during Rabi season, 2011-2012.

Treatments	Plant height (cm)	Scape height (cm)	Number of umbels/ plant	Diameter of umbel (cm)	Number of flowers/ umbel	Number of seed settings/ umbel	Seed settings/ umbel (%)	1000-grain (g)	Seed yield (kg/ha)
T_1= Onion + coriander	98.67a	95.33a	3.80a	7.78a	529.7a	372.7a	70.50a	3.11a	1064.59a
T_2=Onion + Dill	105.27a	101.72a	3.58a	7.53a	537.0a	388.7a	72.37a	3.01a	1040.35a
T_3= Onion+ Fennel	103.55a	100.15a	3.70a	7.62a	546.3a	402.3a	73.70a	3.05a	1165.34a
T_4= Control*	99.00a	95.67a	3.50a	7.57a	533.7a	307.7b	57.73b	3.09a	685.44b
Level of significance	NS	NS	NS	NS	NS	**	*	NS	**
CV (%)	10.14	8.91	12.44	6.30	7.19	5.48	7.28	2.59	6.45

In a column, means followed by the same letters did not differ significantly at 5% levels of probability. *Control (without attractants crop), Mean plant population:$T_{1=243200/ha,}$ $T_{2=241850,}$ $T_{3=242500,}$ $T_{4=244325}$

The scape height of onion followed similar trend of results as in plant height (Table 1&2). In 2010-11, the longest scape was recorded in Onion + Fennel (89.71 cm) which was followed by Onion + Coriander (88.59 cm) and sole onion (87.50 cm) while the longest scape was recorded from onion + Dill (101.72cm) which was followed by Onion + Fennel (100.15cm), Sole onion (95.67 cm) and , Onion + Coriander (95.33cm) during 2010-12.

Different attractants had no significant effects on the number of umbels per plant, however, the highest number of umbels per plant was counted in Onion + Black cumin treatment (3.66/plant) in 2010-11 while it was highest in Onion + Fennel (3.80/plant) during 2011-12.

No significant influence of attractants was observed on the diameter of umbel, however, the highest diameter was measured in Onion + Fennel followed by Onion + Black cumin (7.66 cm) and sole onion (7.71 cm) during 2010-11 while it was highest in Onion + Coriander (7.78cm) during 2011-12.

In both the years, different attractant had no significant effect on the number of flowers per umbel, however, the highest number of flowers were recorded in sole onion (528/umbel) which was followed by Onion + Fennel (523.3/umbel) and onion + coriander (518.3/umbel) during 2010-11 but it was highest in Onion + Fennel (546.3/umbel) during 2011-12.

The influence of attractants was found non-significant on the 1000-grain weight of onion. The heaviest 1000-grain was recorded in Onion + Fennel (3.04 g) in 2010-11 while it was heaviest in Onion + Coriander (3.11g) in 2011-12.

Different attractants had marked impact on the number of seed settings per umbel (Table 1&2). In 2010-11, the highest number of seed setting was recorded in Onion + Fennel (363.7/umbel) which was identical to Onion + Coriander (346.7/umbel) while the highest number of seed setting was recorded in Onion + Fennel (402.3/umbel) which was identical to Onion + Dill (378.58/umbel) and Onion + Coriander (382.97/umbel) during 2011-12. In both the years, the lowest seed setting was recorded in sole onion (295.3/umbel in 2010-11 and 307.7/umbel in 2011-12). In 2010-11, the highest seed setting in Onion + Fennel might be due the fact that fennel attracts more pollinator insects to onion which positively pollinate more flowers for seed settings. Earlier, it was also mentioned that fennel was one of the best attractant crop for pollination. The identical results in Onion + Coriander might be due to the same reason where Coriander was the second best attractant for crop pollination. In 2011-12, more pollinator was attracted by the Dill followed Fennel but seed settings was slightly higher in Fennel.

Different attractants exhibit significant influence on percent seed settings in onion (Table 1&2). In 2010-11, the highest seed setting was recorded in onion + Fennel (69.88%) which was identical to Onion + Coriander (67.45 %) and Onion + Black cumin (64.15 %) while the highest seed setting was recorded in Onion + Fennel (73.70%) which was identical to Onion + Coriander (72.37%) and Onion + Dill (70.50%)during 2011-12. The percent seed setting was found highest in 2011-12 compared to 2010-11. The percent seed setting was lowest in Sole onion (55.93 % in 2010-11 and 57.73% in 2011-12). The lowest seed settings in sole onion might be due to absence of attractants crop in the onion field. Non-availability of pollinators during the flowering period of onion causes only 17% fruit setting and free availability of pollinators increased fruiting up to 73% (Rao and Sunyanarayana, 1989). Ahmed *et. al*.(2009) reported 70- 72% seed settings in summer onion in Bangladesh. Similarly, Mondal and Hossain (1980) claimed 60-65 % seed settings in onion on 30 October planting.

Different attractants crop demonstrated marked influence on the seed yield of onion. In 2010-11, the highest seed yield (865.5 kg/ha) was obtained from Onion + Fennel which was identical to Onion + Coriander (838.1 kg/ha) but differed significantly from other treatments. Similarly, the highest seed yield (1165.34 kg/ha) was obtained from Onion + Fennel which was identical to Onion + Coriander (1064.59 kg/ha) during 2011-12. The lowest seed yield was recorded from Sole onion (623.3 kg/ha in 2010-11 and 685.44 kg/ha in 2011-12).

In addition to this, about 1.37, 1.45 and 0.53 t/ha of Fennel, Coriander and Black cumin was harvested as an inter-crop seed yield in 2010-11 while it was 1.05, 1.15 and 0.58 t/ha of fennel, coriander and Dill during 2011-12. In 2010-11, the highest seed yield in Onion + fennel might be due to the fact that fennel attracts more insects pollinator (Fig. 13) which positively pollinate more flowers for seed settings. Again, the number visits of all insect were more in fennel and corresponding visit in onion is also more. Pollinator visits from one plant to another plant and create pollination. Therefore, more visits might have a chance to cause more pollination. The consequence of which resulted in more seed settings and seed yield of onion in Onion + Fennel treatments.

In 2011-12, Dill attracted more pollinator followed by fennel but seed settings was slightly higher in fennel which resulted higher seed yield in fennel. Further, seed settings in Dill were slightly lower compared to coriander so the yield was slightly lower. This was because part of the onion plot along the edge was covered by the over growth of Dill which hampered growth and pollination in that part, the consequence of which reduced seed yield. Pollinator goes to a flower seeking nectar and, in the process, pollen from the male part of the flower sticks to the pollinator's legs or other parts of its body. When it flies on to another flower of the same type, the pollen is deposited on the female part of the plant. This allows the plant to reproduce by creating seeds and fruit (CWF, 2008). The identical results in Onion + Coriander might be due to the same reason where Coriander was the second best attractant for crop pollination. Without attractant crops in sole onion might be the reason for lowest yield. In case of Black cumin, in Onion +Black cumin treatment more pollinator insect visited compared to Sole onion. Again, the vigilance of pollinator on onion was lower compared to Onion + Fennel and Onion + Coriander because of lower height of Black cumin. Pollinator visited on lower height Black cumin did not prefer to visit on longer height onion in Onion + Black cumin treatments. As result pollination was poor consequently the yield was lower.

Conclusion

Higher seed setting and obtaining higher seed yield of onion, Pollinator attractant crop Fennel and/or Coriander can be planted in a sequence of two rows for every alternate 10 rows of onion including border. Height of the pollinator attractant crops if possible should be nearly same as that of onion. Planting of attractant crops should be synchronize in such a way so that flowering period of the attractant crops should be at least at the same time of onion. Fennel should be planted at the time of onion planting. Coriander should be planted 20-22 days after onion planting. Dill should be planted on the day of onion planting but further study may be needed for Dill regarding its performance for onion seed settings.

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