The effect of honeybee (Apis mellifera L.) on seed production of Allium cepain the Ethiopian Rift valley

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Abstract

Shallot (Allium cepa var Adama Red) is one of the most widely cultivated and favorite vegetable crop in Ethiopia. The information on the honeybee pollination requirement of the crop with local honeybees is scanty in the country. The effect of honey bee pollination on seed yield of Allium cepa, Adama Red variety, was studied at Melkasa Agricultural Research Center for the period of 2000-2001 planting years to see the role of honeybee pollination in increasing seed yield of the onion and to identify the potential pollinators of the crop other than honeybees. The Adama Red variety was planted on plot size of $9m^2$ following the necessary agronomic recommendation. Three treatments were used and replicated three times in Randomized Complete Block Design. The seed yield was found to be significantly different between the treatments ($P< 0.05$). The yield obtained from the plots caged with honeybee pollination was highest with mean seed yield of 17.3 q/ha followed by plots left open under natural condition to be pollinated by all visiting insects with mean yield of 9.5q/ha. The lowest mean yield of 5.4 q/ha was recorded from the plots excluded from honeybees and other pollinators. With regard to 1000 seed weight, treatment three (caged with out honey bees) is significantly different from treatment one and two. Among the pollinators identified, honeybees and stingless bees are the major pollinators of the onion, and they have great contribution for seed yield of the crop. Therefore, on farm demonstration of this pollination technology to onion seed producers is highly recommended and honeybee pollination should be considered as one of the inputs for the onion seed production. Furthermore, investigation and domestication of sting less bee as potential pollinator of the crop is vital for better seed production and biodiversity conservation.

Key words: Pollination, Adama Red, Apis mellifera, Rift valley

Introduction

The survival and maintenance of genetic diversity of many crops and wild plant populations depend largely upon insect pollinators (FAO, 2004). Insect pollinators are essential for fruit, vegetable, oil crops, legumes and wild plant species. As a result the need for insect pollination is becoming popular by agricultural community to increase the productivity of the crops.

Lack of sufficient pollination is one of the limiting factors in agricultural crop productivity. According to Free (1970) and McGegor (1976), honeybee pollination not

only improves the seed production but also the quality of seeds. On the other hand, pollination deficiency in crops results in reduced yields due to lower fruit and seed set, longer germination ability and increased inbreeding depression within a crop population (Kozin, 1968).

A. cepa is one of the oldest cultivated cash crop species and the most popular vegetables in the world. It is believed to be a native to Middle East and India and now cultivated throughout the tropics in drier or under irrigation. It is also an important condiment and vegetable crop in Ethiopia (Getachew and Asfaw, 2000). It serves as a spice for flavoring local dishes and hence is highly popularized in the country. Though the price varies from time to time, it fetches very high price during rituals and holidays.

It is produced by small scale farmers, commercial growers and state farms for both domestic consumption and export purpose (Lemma, 1998). According to Ministry of Foreign Trade (1998 and 1999), a total of 13.4 and 15.8 thousand tons of vegetables with values of 25.4 and 30.5 million Birr, respectively have been exported of which onion had a share of 11 % (Dawit *et al*., 2004).

There have been a number of investigations on the pollination requirements of *A. cepa* in different countries. McGregor (1976) has summarized honeybees are effective pollinators on *A. cepa* flowers because both pollen and nectar are available from it. In tropics, Singh and Dharamwal (1970) also found that honeybees are the major pollinators of onion (Patna Red cultivar).

A. cepa is highly cross-pollinated and its out crossing rate is 93% (Frankel & Galun,1977) and the use of male-sterile plants is essential for the production of hybrid seed. Voss (1979) also reported that the cross pollination varies between 30 to 94% depending on availability of pollinators and its pollen is usually shed before the female part is receptive.

At present, the need for onion seed production is highly demanding by different individual farmers, farming communities and investors in the country. The seeds are imported from abroad with hard foreign currency. These have also been recognized to have problem of germination, and are easily susceptible to disease (Lemma, 1988). The productivity of the crop is very low under natural condition when the crop is left with inadequate honeybee pollination. The low seed yield of *A. cepa* has been reported from open pollination (at natural condition) from small scale producers and state farms (personal communication at upper Awash). Therefore, this study was designed to see the role of local honeybees pollination in increasing the yield of *A. cepa*, and to identify potential insect pollinators other than honeybees.

Materials and methods

Study area

The experiment was conducted at Melkassa Agricultural Research Center, situated at 8° 24 N latitude and 39° 21E longitude in the Upper Awash Valley 15km south-east of the town of Nazreth on the way to Asella. The Center is characterized with the soil types of Cambisols, intermediate altitude (1550m.a,s.l.), high daily mean temperature (20°C) and rain fall less than 500mm during the main season.

Experimental set up

The experiment was designed into three treatments and each treatment was replicated three times in Randomized Complete Block Design (RCBD). The *Allium cepa*, (Adama Red variety), was used for the purpose. The bulb was raised during the growing season and transplanted into 3mx3m ($9m^2$) seedling bed and recommended agronomic practices applicable to the crop were used. In the first treatment at the 50% of flowering of the onion flowers , honeybee colonies were enclosed with nylon mesh wire for the intensive pollination. In the second treatment, the plant was caged with nylon mesh without inclusion of honeybee colonies and other insect pollinators. In the third treatment, the plant was left open for natural pollination as control. The comparative efficiency of each treatment was evaluated on the basis of seed yield per plots and 1000seed weight.

Observation on the visits of pollinators were recorded daily from the day crop started blooming till the flowers were shade. Visiting insect were collected and identified by the entomologist at Entomological Laboratory of Holeta Agricultural Research Center

Statistical analysis

The data were analyzed using the Statistical Analysis System (SAS) computer package (SAS, 2002). The honey bee pollination effect (treatments) was considered as independent variable while seed yield and 1000seed weight are dependent variable.

Results and Discussions

The yield in terms of grain was found to be significantly different between the treatments ($P<0.05$). The yield obtained from the plots pollinated by honeybee colonies were superior with highest mean seed yields of 17.3 quintals per hectare followed by the plot left open to be pollinated by all visiting insects produced the yield of 9.5 quintals per hectare. The lowest yield 5.4 quintals per hectare was obtained from treatment with all pollinators excluded including honeybees (Table1). The seed

yield difference between the treatments indicated that the crop requires insect pollination particularly honeybees and other insect pollinators for seed production. This is in agreement with Free (1970), Jones (1963), and (leader house, 1968) who showed that *A. cepa* flowers are highly self incompatible with delayed female maturity (protandry) and hence the crop favors cross pollination. Consequently, pollinating insects particularly honeybees have a great contribution for improving the seed yield of the crop. McGregor (1976) and Pesson and Louveaux, (1984) have also investigated that honeybees are used to pollinate the *Allium cepa* in large cages for hybrid seed production.

With regard to 1000 seed weight, treatment three (pollinated without honeybees) was significantly different (P< 0.05) from treatment one (caged with honeybees) and treatment two (open pollinated) (Table 1). This may be due to smaller seeds in self pollinated flowers that might have less competition for food during the seed maturity stage as result seeds gained better seed weight. From this investigation honeybee pollination has no significant impact on quality of onion seeds. Similar finding was also reported by Admassu and Nuru (2000), in which they indicated that honey bee pollination has no significant effect on 1000seed weight and germination percentage of Niger (*Guizotia abyssinica).*

During flowering time of *Allium cepa*, various insect orders were recorded. The identified pollinators are butter fly, different flies, honeybees, sting less bees, wasps and carpenter bees. The number and percentage of insect visitors were shown in (Table 2). Among the insect visitors, honeybees and stingless bees (Meliponin spp) are the major pollinators of onion flowers due to their polylectic diet for pollen and nectar. This observation is in agreement with findings of Frankel and Galun (1977) who reported that the plant secretes the nectar with sugar concentration of 30 to 50% and hence it attracts many insect visitors. Trehene (1923); Free(1970); also found that honeybees, stinglees bees, Diptera and solitary bees are also important pollinators of the red onion cultivar in India.

Table1: The mean seed yield and 1000 seed weight of the Allium cepa (Adama red) from three treatments grown in 2000 and 2001 planting year

Mean seed yield in (Quintal)				1000 seed weight (gm)		
Treatments	2000	2001	Combined	2000	2001	Combined
A	17.5±0.08**	17.1±0.70**	17.3±0.53 **	3.2 ±0.01ns	3.4± 0.03ns	3.4±0.5ns
B	10±0.08 **	9±0.70**	9.5±0.5**	3.2 ±0. 01ns	3.3± 0.03ns	3.3±0.5ns
C	5±0.08 **	6±0.70**	5.4±0.5**	3.9*±0.01	3.3± 0.03 ns	3.6 ±0.5*
CV	2.66	7.8	6.66	2.8	5.2	6.6
LSD	0.654	1.906	0.917	0.226	0.3	0.18

ns, *, ** indicates non significant, significant and highly significant differences, respectively. A= With honeybees B= Open pollinated C= without honeybees

Table 2: The number and per cent of the visiting insects on Allium cepa, Adama Red Variety

Insect order	Common name	Number	Per cent
Lepidoptera	Butter fly	25	6.4
Diptera	Fly	75	19.2
Hymenoptera	Honeybees	150	38.4
Hymenoptera	Sting less bees	90	23.07
Hymenoptera	Wasps	35	8.9
Hymenoptera	Carpenter bees	15	3.8

In conclusion, the study revealed that Adama Red variety is largely dependant on honeybee pollination for increasing seed production and there fore moving honeybee colonies to the onion field during its flowering time is the most essential practice for onion seed production. It was also observed that onion flowers visited by various insect pollinators particularly stingless bees, and domestication and management of this beneficial insect is essential for increased production of crop.

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