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The Impact of Wild Bees on the Pollination of Eight Okra Genotypes Under Semi-arid Mediterranian Conditions

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ABSTRACT

A field study was conducted during 2002 in northern Jordan, to determine the performance of eight okra genotypes and their response to two sets of pollination conditions [control (plants in a cage with no insect pollinators) and open pollination (plants accessible to naturally occurring insect pollinators. Significant differences ($P \leq 0.05$) in number of seeds per plant, number of flower per plant, number of seeds per pod, seed weight per plant, and pod length were recorded between the genotypes studied. Clemson gave the highest seed weight per plant. The number of seeds per plant, number of seeds per pod, seed weight per plant, and pod length was greater in insects pollinated plants than self-pollinated plants**.** Insect-pollinated plants showed a greater number of young pods and mature pods due to greater transformation of flowers into young pods.

Key Words: Okra; Insect; Pollination

INTRODUCTION

Okra is a tall growing warm season plant from the same family as *hibiscus.* The immature okra pods are used in soups, stir-fries, and stews. Pollination is an essential stage in the reproduction of flowering plants. It is the transfer of pollen from male to the female part of a flower (McGregor, 1976; Crane & Walker, 1984). Yield instability is generally considered a major problem in okra. As in many other crops, the number of both flowers and ovules that are formed almost always greatly exceeds the resulting number of pods and seeds that are produced. The reproductive system of okra is a mixture of cross- and self-pollination. Insect play a significant role in the fertilization of flowers but the indiscriminate and treadmill use of pesticides reduced the number of various pollinators tremendously. Pollination is an important link in fertilization, a complex process resulting in the production of vegetables, seeds, and seeds of flowering crops. Mohammad (1953) reported that only 37% of bagged flowers were able to form pods themselves as compared to 100% pod formation occurring in cross-pollinated toria (*Brassica napus*). According to Kremer (1945), most grain producing crops require the serves of insects for cross-pollination, of which honeybees are the most satisfactory pollinators. Sneep (1952) mentioned that better yield of crops can be obtained from honeybee pollination in greenhouses. Sampson (1957) showed that compatibility varies with species, cultivars, and even with age of the plant. Eckert (1959) reported that heavy pollens were carried by insects, mostly honeybees, while light ones by wind. Howard (1975) reported that more than 80% of all pollination required for setting of seed and seed crops is accomplished through honeybees. The objective of this research was to study the performance of two eight okra genotypes and their response to two sets of pollination conditions i.e., with and without insect polinations.

MATERIALS AND METHODS

The experiment was conducted during 2002 in northern Jordan. The location has a Mediterranean climate with mild rainy winters (300-350 mm) and dry hot summers. The soils used were shallow rocky silty clays. pH of the top 10-cm of the < 2-mm fraction of soil collected before the experiments started, was 8.1 (Mc-Lean, 1982) and phosphorus extracted by 0.5 sodium bicarbonate at pH 8.5 (Olsen *et al.*, 1954) ranged from 2.3 to 6.0 mg kg^{-1}. The experimental field received granular fertilizers DAP (diammonium phosphate 18% N and 46% P_2O_5) at rate of 100 kg ha^{-1}, which was applied and mixed with soil prior to planting. Split plot design with three replications was used. The cultivars (Local (landrace), Mousel (Iraq), Pakistani, Perkins dwarf spinless (Bonanza seed, Clemson spinless (Modesto seed), Clemson (Steen seed), Clemson spinless (Qulsensenke) and Perkines spinless) were randomly assigned to the main plots in each replicate. Pollination studies were randomly assigned to each cultivar plot, representing the sub plot treatments. For the pollination studies, two sets were used: control (plants in a cage with no insect pollinators) and open pollination (plants accessible to naturally occurring insect pollinators. In each replication, there were 12 plants of each genotype in a single row. Distance between the rows was 70 cm and plants were spaced 30 cm within the row, resulting in a sowing density common in the area. The seed were sown by hand on the 1^{st}

March 2002.The alleys between replicates were 1m wide.

Measurements. Number of pods per plant, number of flower per plant, number of seeds per pod, seed number per plant, seed weight per plant, and pod length.

Statistical analysis. Data for each trait were analyzed for a randomized complete block design (RCBD) with split plot arrangement according to Steel and Torrie (1980). Comparisons between means were made using Least Significant Differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

Significant differences ($P \leq 0.05$) in number of seeds per plant, number of flower per plant, number of seeds per pod, seed weight per plant, and pod length were recorded between the genotypes studied. Clemson gave the highest seed yield. This might be attributed to a longer pod (9.5-cm), more seeds per plant (891), more seeds per pod (49.5), more flowers per plant (14.0) and heavier seed weight per plant (8.8 g). Pakistani gave the lowest seed yield. The variation is related to the differences in genetic material among genotypes. The data given in Tables I and II indicate that, on the whole, higher numbers of seeds and seed weight per plant were obtained from the plants pollinated by insects than self-pollinated. Insect-pollinated plants showed a greater number of young pods and mature pods due to greater transformation of flowers into young pods. On the other hand, no significant differences were found between insect- and self-pollinated plants for the number of flowers. Insect-pollinated plants developed a greater percentage of flowers into young pods than selfed plants. Also, Insect pollination increased the number of seeds per mature pods in all genotypes and the development of fertilized ovules into seed. These results are similar to those Suso *et al.* (1995). Insect pollination had a shorter flower life and flowering period (Barbier, 1978; Lerin, 1982; Williams, 1984). The plants pollinated by insects produced 7.1 g seed plant^{-1} as compared to 3.9 g obtained from non-pollinated plants. During observations, it was also noted that the retention and size of the seeds were greater in the insect pollinated plants than self-pollinated ones. The number of seeds per plant was greater in insect's pollinated plants than self-pollinated plants. Thus, the data indicate that okra is basically an insects-pollinated crop. The results of the study also tally with the findings of the previous workers (Lerin, 1982). The data were analyzed and found to be highly

Table I. Pods plant^{-1}, seeds pod^{-1}, and seed weight plant^{-1} of okra plant as affected by genotypes and pollination conditions

Genotypes	Pods plant^{-1}	Seeds pod^{-1}	Seed weight plant^{-1} (g)
Local (landrace	11.5	29.0	5.0
Mousel (Iraq)	10.0	34.5	4.0
Pakistani	10.0	20.0	4.5
Perkins dwarf spinless (Bonanza seed)	7.0	30.5	3.8
Clemson spinless (Modesto seed)	12.0	21.0	4.0
Clemson (Steen seed)	18.0	49.5	8.8
Clemson spinless (Qulsensenke)	15.0	28.0	7.5
Perkines spinless (ASGrow)	13.0	28.0	6.5
LSD (0.05)	2.1	4.3	0.9
Pollination conditions			
Control	10.3	20.9	3.9
Open pollination	13.9	39.3	7.1
LSD (0.05)	*3.1*	*5.7*	*2.1*
Interaction	NS	NS	NS

Table II. Flowers plant^{-1}, seeds plant^{-1} and pod length (cm) of okra plant as affected by genotypes and pollination conditions

Genotypes	Flowers plant^{-1}	Seeds plant^{-1}	Pod length (cm)
Local (landrace	6.0	333.5	6.5
Mousel (Iraq)	8.0	345.0	6.3
Pakistani	8.0	200.0	9.5
Perkins dwarf spinless (Bonanza seed)	5.0	213.5	5.0
Clemson spinless (Modesto seed)	10.0	252.0	7.5
Clemson (Steen seed)	14.0	891.0	9.5
Clemson spinless (Qulsensenke)	11.0	420.0	8.5
Perkines spinless (ASGrow)	8.0	364.0	10.0
LSD (0.05)	1.4	32.3	0.8
Pollination conditions			
Control	8.8	215.3	6.1
Open pollination	8.8	546.3	9.6
LSD (0.05)	*NS*	*44.0*	*0.9*
Interaction	NS	NS	NS

[Control (plants in a cage with no insect pollinators) and open pollination (plants accessible to naturally occurring insect pollinators significant as shown in Tables I and II**.** As seen from Table I the average seed bearing seeds per plant were 546.3 in insect pollinated plants and 215.3 in self-pollinated plants. The seed formation is maximum in insect pollinated plants and the least number of seeds in self-pollinated plants. It is quite evident that insects helped in pollination and formation of seeds in okra. The increase in yield of okra seed due to insect pollination over self-pollination was recorded to be 45%. The insects pollinated brassica plants have shown 159.31% increase in seed yield as compared to 100 increase shown by Latif *et al.* (1960), 66% reported by Koutensky (1959) and 13% by Free and Nuttal (1968).

Under the condition that prevailed in this study, our results demonstrate that insects help in pollination of okra plants. All genotypes produced higher seed yield with insect pollinations than without insect pollinations

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REFERENCES

Barbier, E., 1978. Pollination du colza par les abeilles. *Rev. Fr. Apic.,* 365: 285–91

Crane, E. and P. Walker, 1984. Directory of Important World Honey Sources. p. 187. *Int. Bee Res. Assoc., (IBRA)* London.

Eckert, J.E., 1959. Honey bee in crop pollination. *California Agri. Expert. Ext. Service.* No, 32. University of California, USA.

Free, J.B. and P.M. Nuttal, 1968. The pollination of oil seed rape (*Brassica napus*) and behaviour of bees on the crop. *J. Agric. Sci.,* 71: 91–4

Howard, C., 1975. The hive and honeybee. Dadant. *American Bee J.,* pp: 275–86

Kremer, J.C., 1945. Influence of honeybee visits on radish seed yield. *Michigan Univ. Agric. Expert Sta. Bull.,* 27: 413–20

Koutensky, J., 1959. The pollination effect of the honeybee (*Apis mellifera* L.) on the increase in rape and white mustard yields per hectare. *Ceskoslov, Akad. Zemedal, red, sbon, Rostlinna Vvvba,* 32: 571–82 (In Czech) AA. 441/631

Latif, A., A. Qayum and M. Abbas, 1960. The role of *Apis indica* in the pollination of toria (*Brassica napus*) and sarson (*B. campestris*). *Bee World,* 41: 283–6

Lerin, J., 1982. Effects de la pollinisiation entomophile sur le colza dans une experience en cage. *Agronomie,* 2: 249–56

Mc-Lean, E.O., 1982. Soil pH and Lime Requirement. *In:* Miller, A.L. and D.R. Keeny (eds.), *Methods of Soil Analysis. Part II,* 2nd Ed., pp: 59–69

McGregor, S.E., 1976. Insect Pollination of Cultivated Crop Plants. *Agric. Handbook No. 496. U.S. Deptt. Agri., Washington, D.C.,* VIII: 411

Mohammad, A., 1953. Pollination stuides in toria (*Brassica napus*) and sarson (*B. campestris*). *Indian J. Agric. Sci.,* 5: 125–4

Olsen, S.R., C.V. Cole, F.S. Watunable and L.A. Dean, 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *U.S. Dept. Agric. Circ*., 393. USAD, Washington, D.C. USA

Sampson, D.R., 1957. The genetics of self and cross-incompatibility in *Brassica oleracea*. *Genetics,* 42: 252–63

Sneep, J., 1952. Selection and Breeding of some brassica plants. *In: Proc. XIIth Int. Hort. Congress*. pp: 422–6. University of Edinburgh, U.K.

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedures of Statistics, A Biometrical Approach.* McGraw-Hill Book Company, USA

Suso, M.J., J.I. Cubero and M.T. Moreno, 1995. Outcrossing in two faba bean cultivars under dryland conditions in Spain. *Canadian J. Plant. Sci.,* 75: 441–3

Williams I.H., 1984. The concentrations of air-borne rape pollen over a crop of oil-seed rape (*Brassica napus* L.). *J. Agric. Sci., (Camb)* 103: 553–57

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