

A Review of Some Factors Influencing Seed Setting In Alfalfa

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Seed setting in alfalfa is at best very uncertain. The declining yield of seed in the main seed producing areas of this country is of much concern to alfalfa growers everywhere. What the factors are which determine a good or poor seed set have been the object of intensive and coordinated studies at a number of experiment stations in recent years. A report of these studies, and a brief review of other findings are given in six papers published as a symposium in a recent issue of the Journal of the American Society of Agronomy¹. The final answer and solution to this perplexing problem is not even now known but the results of the studies under way have given evidence that is of interest to all alfalfa growers.

The studies have proceeded along several lines: (1) Is tripping in the alfalfa flower necessary for pod formation and seed setting? (2) What causes tripping? (3) Artificial tripping. (4) The role of insects. (5) The importance of cross pollination. (6) Harmful insects and their control. (7) Environmental factors which influence seed set and seed development. (8) Varieties and plant selection in relation to seed set. I shall attempt here to summarize briefly the results of these recent investigations.

The Alfalfa Flower

In the alfalfa flower the stamens are largely united enclosing the pistil. This entire body called the "sexual column" remains enclosed by the "keel" petals. Tripping occurs when thru pressure or other disturbance these "keel" petals are parted releasing the column allowing it to snap forward. As a result of tripping the stigma is exposed allowing it to come in contact with the pollen.

There is now general agreement among workers that tripping is necessary for pod formation and good seed set. Some seed formation may take place

without tripping but such setting does not occur sufficiently frequent to make for dependable seed production. Knowing that tripping is necessary there is much interest in knowing what causes it and the environmental conditions or outside forces necessary to insure a larger proportion of the flowers being tripped.

Some of the factors observed as influencing the amount of tripping, but not considered of enough importance by themselves in insuring successful seed production, are: (1) Flowers trip more easily on warm bright days than when cloudy and cool. (2) Some plants trip more eas-

¹Vol. 38 No. 6, pp. 462-535 (1946)

ly than others and an occasional plant is self-tripping, but these are too rare to be of much account. (3) A beating rain can cause tripping and a sharp short rain is more effective than a slow steady rain. (4) A strong wind may cause rather violent swaying of plants but this usually does not result in any large proportion of the flowers being tripped. (5) The operation of some machine or drag in a field of alfalfa in full bloom will result in some tripping, but in practice has not brought about any appreciable increase in seed production.

The Importance of Cross Pollination

More and more it has come to be recognized that tripping alone does not insure a good set. Alfalfa flowers are largely self sterile, that is, self-fertilization is usually not successful. Pod formation and a successful seed set, therefore, does not only involve tripping but also the introduction of pollen from other plants to induce pollination and seed formation, i.e. cross pollination. In an alfalfa field this tripping and cross pollination can come about only through the presence of a large number of beneficial insects, especially bees, moving from flower to flower in search of pollen or nectar. In their visits to the flower these insects cause the flowers to trip, and in the tripping process they become dusted with pollen, which they carry to the next flower they visit. In only that way is the necessary cross-pollination brought about.

In an early report, Tysdal¹ found that in open fields an

average of 69% of the tripped blossoms formed pods; 89% of natural crossing occurred and that cross-pollinated flowers averaged 3.8 seeds per pod. To produce one pound of seed it was estimated that 76,300 flowers had to be tripped. Somewhat similar observations have been reported by Knowles², University of Saskatchewan, who in 1941, found 94.2% crossing in alfalfa. The number of tripping and pollinating insects in an alfalfa field, therefore, appears to be of first importance.

Vansell and Todd, studying alfalfa tripping by insects in Utah, found that tripping occurred almost without exception only during the working hours for bees, and the amount of tripping in fields was in proportion to the number of pollen collecting bees present. Practically no tripping occurred on plants from which bees were excluded. Bees gather pollen to feed the young brood.

In Utah the pollen collecting bees, the alkali bee (*Nomia melanderi*) and several species of the leaf cutting bee (*Megachile* spp.) were most effective in tripping. Honey bees (*Apis mellifica*), they found would trip many flowers when collecting pollen but were less efficient when in search of nectar. Bumblebees were effective trippers when after pollen but were able to obtain nectar without tripping the flower. Bumblebees usually were not sufficiently numerous in the Utah fields to account for any appreciable increase in seed production.

Honey bees generally have not been considered effective in tripping alfalfa flowers. Vansell

¹Journal American Society of Agronomy Vol. 32: 570-585, (1940).
²Scientific Agriculture Vol. 24: 29-50 (1943).

and Todd observing the number of flowers tripped and examining pollen traps in fields in which wild bees were largely absent, found that the percentage of blossoms tripped ranged up to 59 percent and that the percentage of alfalfa pollen in traps ranged from 18.2% in the diversified wheat-alfalfa area to 48.2% in the more exclusive alfalfa growing area. They conclude that while honey bees tripped a smaller proportion of the flowers they visited than the other bees, they worked more hours each day, visited many more flowers and usually were more numerous than any other species. North Dakota entomologists point out that species of the leaf cutting bees, and some others which are effective in tripping flowers, are common in our State but the alkali bee is not.

Other Plants Attract Bees

Alfalfa is not a preferred source of pollen for honey bees. The anthers bearing the pollen are concealed within the keel, and tripping the alfalfa flower requires more effort than for most flowers. If other plants more easily worked are present, they will attract the bees away from an alfalfa field. Those mentioned by the Utah investigations include sweet clover, other clovers, mustard, corn, thistles, wild carrot and chicory. These last two are not common in North Dakota but we have gumweed (*Grindelia squarrosa*), sow thistle (*Sonchus arvensis*) and others which do attract bees. The presence or absence of competing pollen producing plants, during the period when the alfalfa is in blossom, is therefore, assumed to have a direct bearing on the yield of alfalfa seed. It

was also observed that honey bees responsible for tripping many flowers when collecting pollen appeared to prefer the less succulent alfalfa. This substantiates general observations frequently made here and elsewhere that the relatively dry warm seasons favor pod and seed production. When collecting nectar the honey bees tripped a smaller proportion of the flowers visited and the more succulent fields were preferred.

Harmful Insects

Some insects are harmful to seed production. The lygus bug (*Lygus* spp.), common in some of the western states including North Dakota, feeding on the alfalfa flower and immature seeds, interferes seriously with alfalfa seed production. Other harmful insects included the alfalfa plant bug (*Adelphocorus* spp), alfalfa weevil (*Hypera postica*), potato leaf hopper (*Empoasca fabae*), grasshoppers (*Melanoplus* spp.), Say's plant bug (*Chlorochroa sayii*) and the chalcis fly (*Bruchophagus funebris*). The alfalfa weevil and the chalcis fly are not common in North Dakota, but other insects found here and considered harmful include blister beetles (*Epicanta* spp) and the common cricket (*Gryllus assimilis*).

How to destroy the harmful insects without also destroying those insects so necessary to successful seed production, has been a matter of careful investigations by Sorenson and Carlson, also by Lieberman. Comparing several insecticides it was found that dusting with DDT was especially effective in accomplishing lygus bug control. Because DDT would remain toxic for a relatively longer period, thus al-

so destroying the nymphs as they developed, it was more effective than sabadilla or pyrethrum dusts. Lieberman found that plots treated with DDT (10%) produced an average of 4.77 seeds per pod. Plots treated twice with Sabadilla (20%) Sabadilla (10%) or pyrethrum contained an average of 2.56, 2.92 and 2.91 seeds respectively per pod. A representative check plot, not treated, averaged only 1.33 seeds per pod. Pollinating bees were not observed to be any more numerous in those treated plots than in the adjacent untreated fields, hence the proportion of tripped flowers in all plots presumably were the same.

While this means of controlling harmful insects and insuring larger seed production is encouraging, these entomologists say further information on dosages and time of application is needed. Applications made early enough to destroy the harmful insects, yet avoiding serious reinfestation before the blossoming season when the pollinating bees will be attracted to the field, will be necessary. The residual effect of the insecticide on the alfalfa plant offers some hazards should the field be cut for hay, pastured or the alfalfa straw used as a feed after threshing. Information here is not complete and conclusions are not final.

Tysdal studying plant growth in relation to seed production concludes that lodging, or conditions associated with recurrent new growth, was harmful to seed production. Weather was credited with playing a large part in seed production, influencing not only the alfalfa plant but the activities of the pollinating insects which are so essen-

tial to successful seed production. Sufficient rain for normal plant growth, but not in the amounts to encourage new growth was considered most favorable.

What Can Be Done

Suggestions insuring more certain and larger seed production may perhaps be considered under about four headings. Some of these can be practiced now, others offer hope for the future.

- (1) Provide conditions favorable for the increase of beneficial pollinating insects, especially honey bees. Honey bees do especially well in North Dakota, are kept in hives, and hives can be distributed as necessary to assure adequate coverage of the field.
- (2) Have the alfalfa field isolated so that pollinating bees have no other choice than to visit alfalfa. Destroy uneconomic plants which produce pollen that may attract bees away from alfalfa, especially during the alfalfa blossoming period.
- (3) Control harmful insects
- (4) In so far as possible plan to have the alfalfa come into bloom when competing plants are least attractive, and when average rainfall and temperature conditions are most favorable for the pollinating insects, and for seed development. This is moderate rainfall and fairly warm temperatures.

(5) Breeding and selection for:

- (a) Higher seed producing types. (The possibilities here appear limited in view of the large importance of pollinating insects).
- (b) Selecting strains of alfalfa more attractive to bees as a source of pollen or nectar.
- (c) Selecting strains that trip easier, insuring that a larger proportion of the flowers visited by pollinating insects will be tripped.
- (d) Develop self tripping strains of alfalfa which also are highly self fertile. (At present improvements in this direction do not look especially hopeful).

For the alfalfa seed grower the suggestions under numbers 1 to 4 offer most immediate promise. Varieties of alfalfa available and suitable for growing in North Dakota do not differ appreciably in seed production. Winter hardiness is an important requisite. Winter hardy varieties, in addition to northern grown Grimm, include Cossack, Ladak and Ranger. Ladak has shown ability to maintain its stand under drought conditions better than Grimm or Cossack. Ladak also has some resistance to bacterial blight, a wilt disease of alfalfa. Ranger, a new variety bred for wilt resistance and winter hardiness, is one of the preferred varieties for the central states and other areas where this disease of alfalfa may be serious. Losses in stand from bacterial wilt are less common here than in areas of relatively higher rainfall.

USE OF FERTILIZERS

In a recent address before the annual convention of the American Plant Food Council, Dr. R. M. Salter, Chief of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, said that the victory the farmers of the United States have won on the "food and fibre front" has been due to seven factors, namely: (1) some 30 years of breeding better plants; (2) improved methods of soil management including the use of fertilizer; (3) the development of the U. S. domestic synthetic ammonia industry; (4) the manufacture of ammonium nitrate on a large scale; (5) new ways of preparing other fertilizing elements for use; (6) the development of domestic potash deposits; and (7) increasing the plant food content of fertilizer mixtures.

As better plants, capable of higher yields are made by the plant breeder, the consumption of the elements of plant food will increase and the demand for fertilizers correspondingly increase. Just as plant breeding increases the draft on the soil for elements of fertility so too do better tillage and irrigation to the extent that they increase yields. (H.L.W.)