Int. Agrophysics, 1994, 8, 489-496

GLUE METHOD FOR MINIMIZE CARROT SEED LOSSES

B. Dobrzański

Institute of Agrophysics, Polish Academy of Sciences, Doświadczalna 4, 20-236 Lublin, Poland

A b s t r a c t. The self-seeding of the seeds on plantations causes irreversible quantitative losses. Thus the knowledge of the variability of this unfavourable plant feature may contribute to decreasing the losses through the appropriate planning of harvest technology. For the evaluation of the carrot umbel susceptibility to shattering, a prototype vibration apparatus with the adjustment of the amplitude and frequency of vibrations was used. For investigations the main, first, and second umbels were taken into consideration. The seeds from the main umbels appeared to be most susceptible to self-seeding. To restrain the process of self-seeding during maturation, spraying of umbels with the glue substances was performed. Six different glues were applied to areas of carrot to reduce seed losses through shattering. Application of the BWD type glues increased seed yield by 30 % and treatment had significant positive effect on seed germination. On the basis of these results a very favourable effect of that measure on the seeds preservation until harvest was confirmed.

K e y w o r d s: carrot, seed losses, glue method

INTRODUCTION

The need for full mechanization of the production of carrot seeds makes it necessary to harvest the seeds in one stage. However, the choice of the correct date of harvesting is made difficult be the spread in seed ripening which amounts to a difference of 4 to 5 weeks between seeds from king umbel and those from third-order umbels [2-5]. This results in considerable losses of seeding material caused by:

- lack of machines designed specially for seed harvesting,
- shattering of seeds from early ripening umbels (caused by wind, rain etc),
- shattering during mechanical harvesting (caused by mechanical vibration and impact),
- gathering of immature seeds from umbels maturing at a later time,
- damage of moist seeds during threshing.

Mechanical harvesting can be facilitated to a considerable degree by desiccation which makes it possible to reduce and equalize the moisture content of seeds and plants [1-5,7]. The aim of previous works [2-5] was to determine the effect of time of desiccation, Reglone concentration and such factors as location, shape and size of umbels, seed density in an umbel, moisture content of seeds and plants and the degree of seed maturity on shattering of carrot seeds. It hoped that the results of those study make it possible to minimize seed losses during mechanical harvesting.

It was found that the lowest self-seeding (3-10 %) occurred at moisture content from 20 to 25 %. However, an increase of seed moisture, caused by the climatic conditions also sharply increases carrot susceptibility to self-seeding, even up to 80 %. Drying of plant in the field below 18 % of humidity, was also very unfavourable because it increased self-seeding to 25 % and more. The first grade seeds with highest germination ability from the main umbels appeared to be most susceptible to self-seeding, decreasing germination of all sowing material.

Williams [8,9] applied polyvinyl acetate glue to reduce seed shattering in onion seed production. Application of the toxin-free PVA glue increased seed yield by 33 %, and it was the reason to try glue treatment in carrot seed crops to minimize qualitative and quantitative losses.

METHOD

Six different glues were applied to 13.5 m^2 areas of carrot in order to reduce seed losses. Four of the glues BWD type were on basis of polystyrene, plexiglass and cyclohexane non-aqueous solvent, one of the glues was polyvinyl acetate (PVA) type. Rubber latex based glue was also applied. The glues BWD type were elaborated for coating whole surface of seedhead or for joint every seeds to each other (Fig. 1).

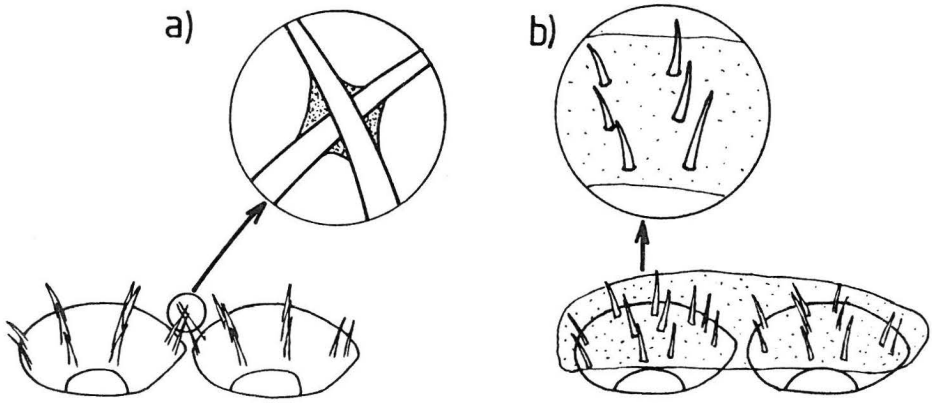

Fig. 1. Contact glue joint (a) and coat glue joint (b).

The quality of glues were checked in following ways:

- the study of mechanical properties of glue joint (two cotton fibers in diamond crossing (30 degree) were sprayed with each type of glue and after drying, the joint was disrupted in tension test),
- the shattering tests of umbel seed heads (with a specially designed shattering simulator) were performed for determination the seed quantitative losses,
- the germination capacity of seeds from umbels sprayed with the glue substances was performed for determination the seed qualitative losses.

Glues were applied by spray-gun after first seed fall from king umbel seedhead (two weeks before desiccation treatment) at rates: 35, 70, 105, 175, and 210 l/ha and after desiccation at the rate 70 l/ha only.

The crop was desiccated with Reglone at rate 6 l/ha in following concentrations: 0.5, 0.75, 1.0, 1.5, 2.0 %, and at the rates: 3, 4.5, 6, 9, 12 l/ha in 1 % concentrations.

Sixty seedheads from each areas of carrot for shattering test were used. The study was conducted with the aid of a specially designed shattering simulator (Fig. 2) employing a vibrator with amplitude and frequency control. The cut umbels were placed in a holder *10* and were shattered 30 s at 50 Hz frequency and 6 mm amplitude. The seeds collected in the container *14* as well as the ones remaining in the umbels were weighed and counted and the percentage ratio of shattered seeds to the total number or weight was calculated. Although this method does not make it possible to determine the actual degree of shattering in the field, it does enable one to make a comparative study of the effect of various factors, as well as varieties, on the degree

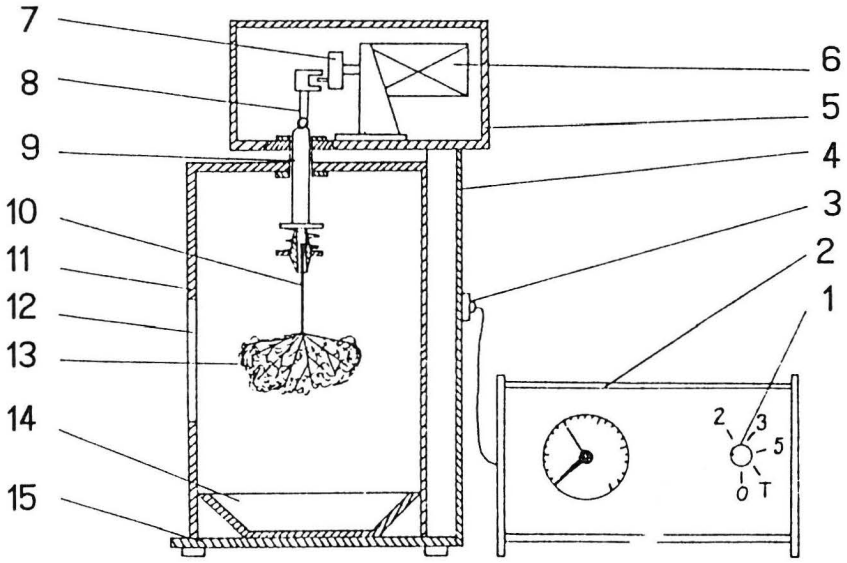

Fig. 2. Shattering set: 1 - potentiometer, 2 - power with frequency control, 3 - connection, 4 - pillar, 5 - drive casing; 6 - direct current motor, 7 - circular cam, 8 - connective rod, 9 - slider, 10 - shoot in holder, 11 - shattering chamber, 12 - sight-glass, 13 - seedhead, 14 - container, 15 - base plate.

of seed shattering. Glued seedheads were also shattered at following frequency: 20, 30, 40, 50, 60, 70, and 80 Hz.

The moisture content of seeds and plants were controlled every day for umbels from king, first-order, and second-order shoots of the Nantejska carrot.

RESULTS

It was found that the moisture content of plants often increased while they were maturing; this was caused by changing atmospheric conditions. The desiccation of the plant was performed at different moisture content of plant. In consequence the studies were carried out on plants containing from 20 to 75 % of moisture. As early as 2 days after desiccation the moisture content of experimental plants fell considerably, particularly in the case of 1.0 %, 1.5 % and 2.0 % Reglone concentration. In the next 2-day period the process of dehydration is not so rapid: only plants treated with lower concentrations of Reglone (0.5 %, 0.75 %) exhibit a uniform reduction in moisture content. As a result, after 4 days the moisture content of seeds and plants equalizes, irrespective of the time of desiccation and the Reglone concentrations (Fig. 3). For comparison the measured control values have also been shown.

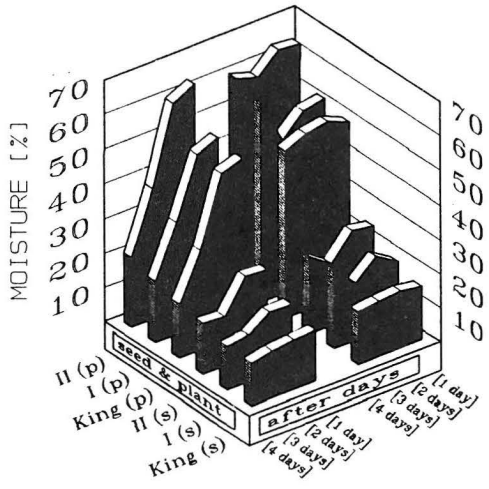

Fig. 3. Moisture content of plants (p) and seeds (s) at 4 day intervals after desiccation with Reglone at the rate of 6 l/600 l/ha.

For all Reglone concentrations germination capacity of seeds was determined. It was found that treatment with Reglone only at the rates 9 l and 12 l caused decrease of germination capacity (Fig. 4).

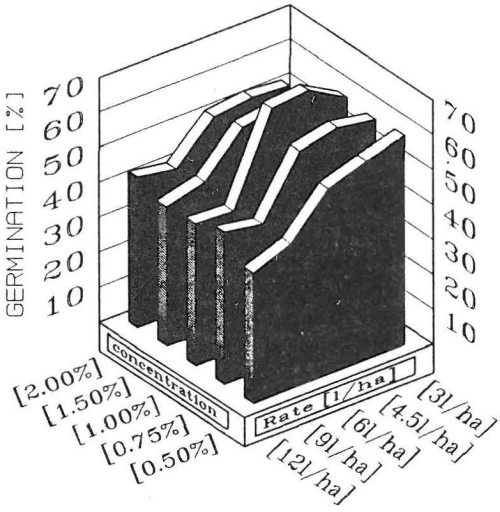

Fig. 4. Germination capacity of seeds desiccated at differant rates and concentrations of Reglone.

The obtained results indicate that at the rate of Reglone 6 l/ha in concentration 1.0 % cause sufficient plant dehydration for mechanical harvesting while keeping the degree of seed shattering at a value close to control (Fig. 5). Plants subjected to deep or rapid desiccation were much more susceptible to seed shattering. It was stated that the lowest self-seeding (3-10 %) occurred at moisture content from 20 to 25 %. An increase of seed moisture, caused by the climatic conditions also sharply increases carrot susceptibility to self-seeding, even up to 80 % [7]. Drying of plant in the field below 18 % of humidity, was also very unfavourable because it increased self-seeding to 25 % and more. In previous works [2-5] it was found that the umbel seedheads with larger diameters, low density and convex shape are more susceptible to seed shattering. The seeds from the main umbels appeared to be most susceptible to self-seeding.

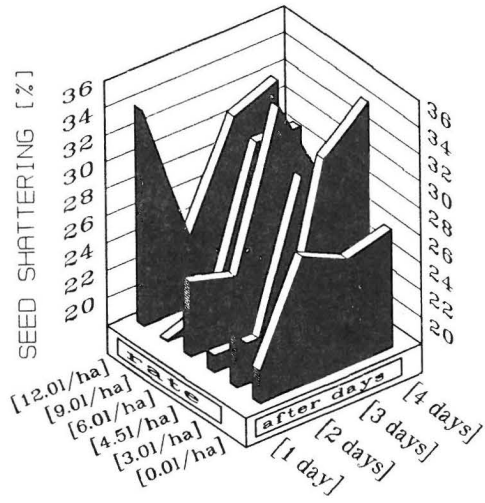

Fig. 5. Carrot seed shattering at different rates of Reglone.

Resuming, for each Reglone concentrations at all rates used for desiccation treatment (irrespective of the atmospheric condition), the seed shattering was observed. To restrain the process of self-seeding during maturation and shattering at direct harvest, spraying with different glues substances to areas of carrot were performed.

The glue BWD II was applied at different rates to choose a minimum rate necessary to keep the seeds with a seedhead. The results suggested that the seed shattering was lowest at the rate 70 l/ha (Fig. 6) for every frequency used in study.

For this reason all glues were applied at the rate 6 l/ha to areas of carrot. Seed shattering for all glues BWD type was similar, reaching values two times lower than from non-glued seedheads shattered at all frequency. Only the glue BWD 12 keep all seeds with seedheads under coat glue joint. The seeds did not shatter at frequency 20-30 Hz (Fig. 7) and at frequency 40-50 Hz seed shattering caused losses not significant. Higher frequency caused damage of seedhead and its broken off part by part, increasing seed shattering.

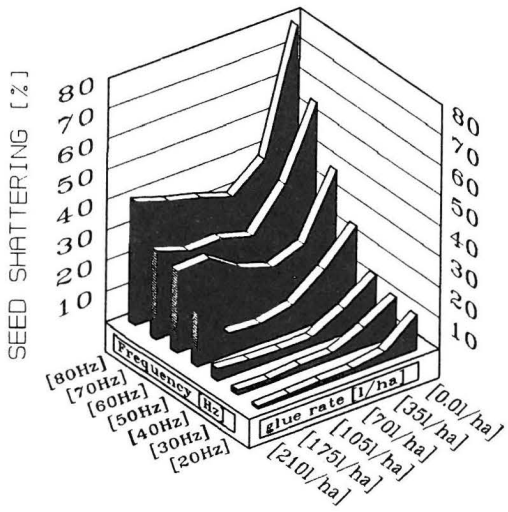

Fig. 6. Seed shattering for different rates of glue BWD II.

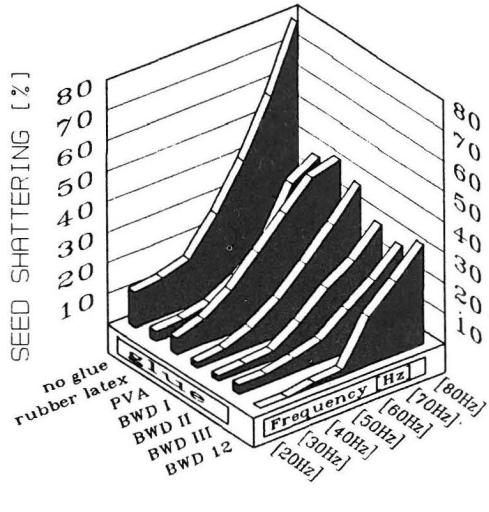

Fig. 7. Seed shattering for different glues.

Some values included in Table 1, connected with mechanical properties of glues, showed that the glues BWD type made the strongest joints of seed-to-seed and seeds-to-seedhead. The joints between two cotton fibers formed by spraying with all BWD glues were stronger in tension and bending tests than thin joint formed by spraying with BWD 12. Spraying with BWD 12 formed a joint with very thin coat that gave possibility to use lower rate of glue and reduce of total solids in glue. However, thin coat of glue joint covering all crop from seedhead reduced seed losses totally.

For all glues applied to carrot areas threshing facility was highest and seeds after threshing were free of glue residue. Only for rubber latex threshing of seedheads was unrealizable.

A quality of glued seeds, a specially with glues BWD type, were higher than for seeds from no-glued seedheads. The treatment with glues BWD type had a significant effect on seed germination (85 % for BWD 12) caused by keeping the heaviest with the best quality seeds from the king umbels - earliest formed seedheads.

On the basis of these results a very favourable effect of glue treatment on the seeds

Table 1. The quality assessment of glues

Assessment	Glue					
	BWD I	BWD II	BWD III	BWD 12	PVA	RL
Glue joint	contact	contact	contact	coat	contact	contact
Tension force (N)	7.1	9.2	8.0	6.7	3.1	3.6
Bending force (N)	2.8	2.2	2.3	1.3	2.4	0.7
Threshability	B	A	A	A	C	E
Drying time	5-10 s	5-10 s	10-15 s	10-15 s	≈ 1h	1-5 h
Germination (%)	78	76	80	85	64	55

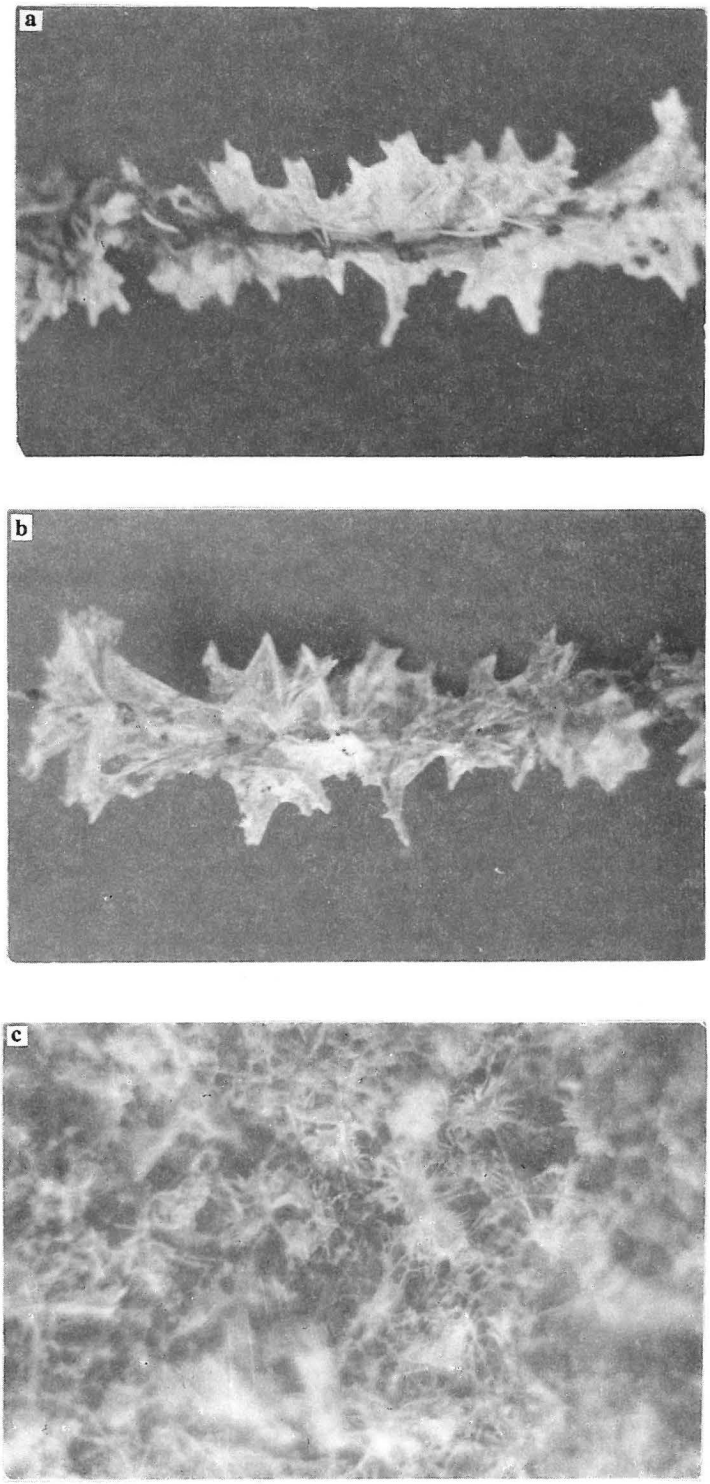

Fig. 8. Surface of seedheads after spraying with glues: a and b - BWD 12, c - BWD I, d - BWD III, e - PVA and f - seeds after threshing.

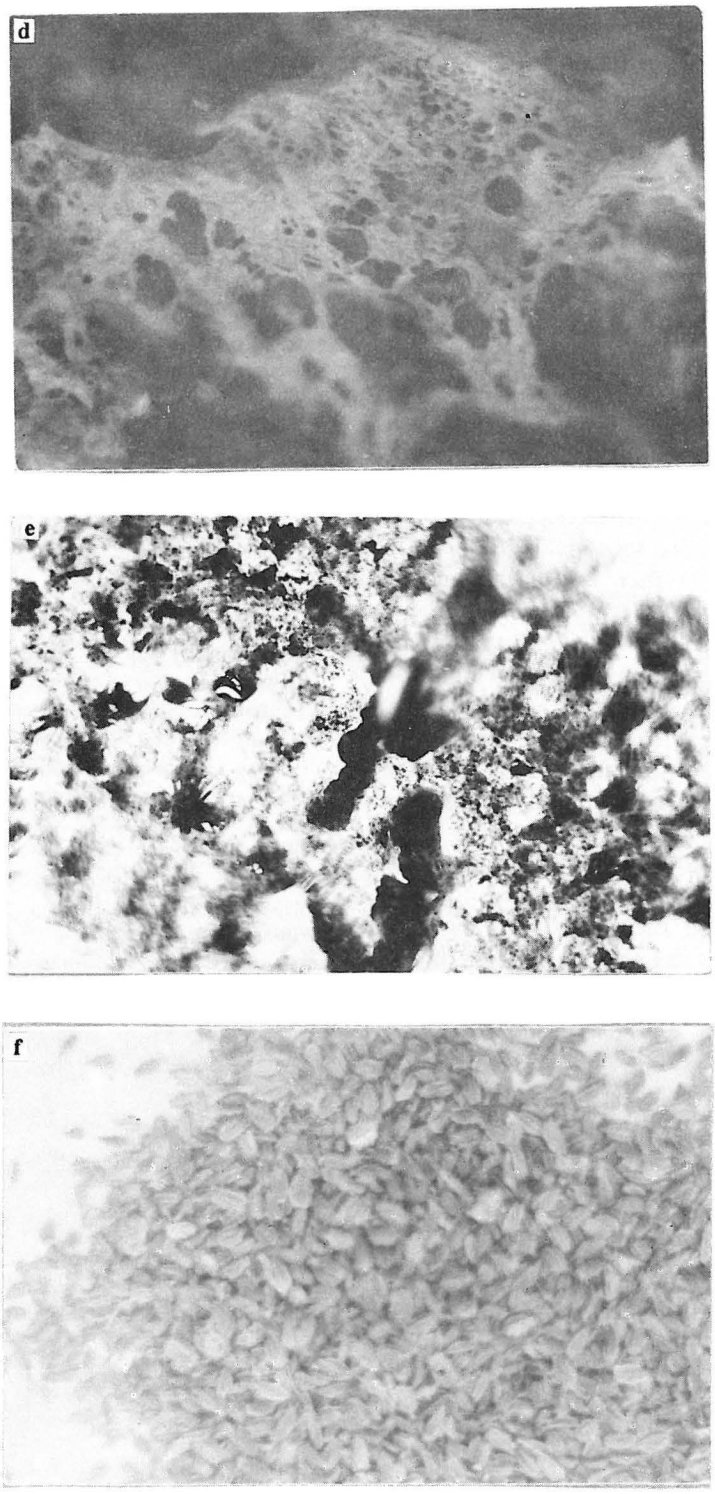

Fig. 8. Continuation.

preservation until harvest was confirmed. Glue spraying is a promising technique to reduce seed shattering during harvest and to increase seed yield.

CONCLUSIONS

1. The seed shattering of carrot seeds causes irreversible quantitative losses related to moisture content of plant, umbel size and shape, weather condition and Reglone rate. Thus the knowledge of the variability of this unfavourable properties may contribute to decreasing the losses, but not to their elimination.

2. Glue spraying is a promising technique to reduce seed shattering before harvest and to increase seed yield. Application of glue to carrot increased seed yield by one-third in all carrot crops.

3. The all glues BWD type did not affect moisture content of plant or germination capacity of seeds.

4. The treatment with glues BWD type had a significant effect on seed germination (85 %) because the best quality seeds from the king umbels were protected in seedheads against self-seeding.

5. Aerial application of glue at a rate of 70 l/ha increased seed yield near by 25 % and germination capacity up to 20 %.

6. Glue spraying is a promising technique to reduce seed shattering during harvest and to increase seed yield and germination capacity of low quality carrot seed.

REFERENCES

1. **Badman L.R., Williams C.M.J.**: Direct harvesting of onion (Alium cepa) seedcrops in South Australia. Int. Cong. ISHSS, Australia, 1662, 1978.
2. **Dobrzański B.**: Factors affecting carrot seed shattering. Proc. 2nd ICPPAM, Gödöllö, Hungary, II, 33, 1980.
3. **Dobrzański B., Szafirowska-Walędzik A.**: Osypywanie nasion marchwi w zależności od stężenia i terminu desykacji jako cecha przydatności do zbioru mechanicznego. Zesz. Probl. Post. Nauk Roln., 293, 31-40, 1980.
4. **Dobrzański B., Szafirowska-Walędzik A.**: Próba oceny osypywania się nasion marchwi. Zesz. Probl. Post. Nauk Roln., 258, 335-342, 1983.
5. **Dobrzański B., Szafirowska A.**: Wpływ Reglone na dynamikę zasychania nasienników marchwi. Hodowla Roślin, 2, 30-33, 1983.
6. **Dobrzański B., Dobrzański W.**: Ograniczenie strat nasion marchwi poprzez zastosowanie substancji klejowych. Mat. Szkoły Letniej: Fizyczne właściwości materiałów roślinnych. Kazimierz Dolny, 7, 1984.
7. **Szot B., Dobrzański B., Dobrzański W.**: Evaluation of carrot susceptibility to self-seeding. Abstracts XXI Int. Hort. Cong., Hamburg, Germany, I, 1514, 1982.
8. **Williams C.M.J.**: Seedhead glueing increases yield and quality in vegetable seed crops. Int. Cong. ISHSS, Australia, 1656, 1978.
9. **Williams C.M.J.**: Evaluation of glue formulations used to reduce seed shattering in onion (Alium cepa) seed crops. Int. Cong. ISHSS, Australia, 1660, 1978.