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COMPARATIVE STUDY OF THE EFFECT OF DIFFERENT WEED MANAGEMENT STRATEGIES ON DISEASE SEVERITY AND MARKETABLE YIELD OF PAPRIKA (*CAPSICUM ANNUUM* L.) IN THE SMALLHOLDER FARMING SECTOR OF ZIMBABWE

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Abstract: On-farm trials were conducted in the Chinyika Resettlement Area of Zimbabwe under dryland conditions to investigate the effects of different weed management methods on disease incidence, severity and paprika (*Capsicum annuum*) pod yield. The weed control treatments included hand weeding at 2 and 6 weeks after transplanting (WAT); ridge re-moulding at 3,6 and 9 WAT; application 4l/ha Lasso (alachlor) immediately after transplanting, and Ronstar (oxidiazinon) at 2l/ha tank mixed with Lasso at 2l/ha one day before transplanting. The herbicide-water solution was applied at the rate of 200l/ha using a knapsack sprayer. Major diseases identified were bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria*), cercospora leaf spot (*Cercospora unamunoi*), grey leaf spot (*Stemphylium solani*) and powdery mildew (*Leveillula taurica*) in both seasons. For the 2000/2001 season hand weeding at 2 and 6 WAT and ridge re-moulding at 3, 6 and 9 WAT had the greatest reduction effect on the area under disease progress curve (AUDPC) and the highest marketable fruit yield. In the 2001/2002 season, both herbicide treatments had the same effect as hand weeding and ridge re-moulding on AUDPC and marketable fruit yield. The least weed density was obtained by ridge re-moulding at 3, 6, and 9 WAT in the 2000/2001 season. Weed density was statistically the same across all treatments except the check treatment in 2001/2002 season. Hand weeding operations were

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significantly ($p < 0.05$) effective and consequently gave the highest added profits mainly because of their effect on major weeds such as *Datura stramonium*.

Key words: *Capsicum annuum* L., weed management, disease incidence and severity, marketable fruit yield, Zimbabwe

INTRODUCTION

Paprika (*Capsicum annuum* L.) fruit yields obtainable on farms in Zimbabwe vary from less than one tonne per hectare in the smallholder farming sector to around six tonnes per hectare in the commercial farming sector (Hyveld Seed 1996). Generally low yield figures recorded in the smallholder sector have been attributed to a number of production-related problems, which include weed (Chivinge and Mariga 2000) and disease (Handiseni *et al*. 2007) management. Several studies have led to the conclusion that paprika is a poor competitor against weeds (Frank *et al.* 1988; Lagoke *et al*.1988). Manual weed control, being an important aspect of the smallholder crop production system, requires a lot of human labour. Although herbicide use appears to be the best option, environmental and economic concerns have led to increased interest in mechanical/manual weed control and reduced herbicide use (Edwards 1987). Affordability, availability, technical know-how and environmental friendliness of any particular weed control method inter-play to determine its choice. Farmers who mainly rely on hoe-weeding find it difficult to weed timely, probably because of the drudgery that it entails. At the beginning of the wet season, land preparation, planting and first weeding all compete for the limited available human labour (Hammerton 1974).

Weeds such as *Datura stramonium* ought to be controlled not only because of economic losses produced by weed-crop competition but also because it is an alternative host of pathogens such as Potato Virus Y (Ormeno *et al.* 2006). De Souza and Café-Filho (2003) reported that inoculation of plants of different botanical taxa including weeds such as *Nicandra physalodes* with a strain of *Leveilula taurica* indicated a wide host range. *Amaranthus spinosus*, *Physalis minima* and *Euphorbia hirta* had the highest incidence of *Ralstonia solanacearum* infection when weeds were tested from a commercial tomato field (Dittapongpitch and Surat 2003).These discoveries suggest that this weed may play a major role in survival of *R. solanacearum* between successive crops and cropping patterns. The South African biovar strain 3 of *Pseudomonas solanacearum,* which causes wilt in potatoes, was isolated from *D. stramonium* and *Solanum nigrum* (Swanepoel 1992). From the epidemiological perspective, management of weed control within the crop and also plants surrounding the upwind edge of the field will reduce the incidence of diseases associated with the weed (Ormeno *et al*. 2006).

Research has shown that transplanted pepper should be kept weed-free for the first 60 days after planting (Labrada and Paredes 1983). This can be done effectively using herbicides that have been recommended for the use in paprika production such as Lasso (alachlor) tank-mixed with Ronstar (oxidiazon) for the control of grass weeds (Hyveld Seed 1996). Pre-emergence application of metribuzin, alachlor and nitrofen has also given significantly higher yield in paprika than in non-treated plots (Singh *et al.* 1984).

The majority of smallholder paprika farmers in Zimbabwe prefer ridge re-moulding as a weed control strategy as it maintains the already established ridges. However, the adoption of any particular weed control method during the course of production is not consistent. On the other hand, most herbicide recommendations do not state the need for and time of additional supplementary hand weeding during the cropping season. Singh *et al*. (1984) noted that hand weeding done once, in addition to an herbicide application, significantly increased fruit yield in tomato. However, farmers have often been unable to cope with the extent of weeding that is required through hand weeding. This has resulted in the abandonment of crop fields to weeds, when farmers could no longer cope with the extent of weed challenge they are faced with in certain instances.

The objective of this study was therefore to compare the effect of different weed management strategies on the disease incidence and marketable fruit yield in paprika.

MATERIALS AND METHODS

On-farm trials were conducted in the Chinyika Resettlement Area (CRA) located in the Eastern province of Zimbabwe. The CRA lies between latitude 18°12'–18°17'S and longitude 32°09'–32°24'E; and has an altitude ranging from 700 to 1 200 m above sea level. Field trials were initiated during the 2000/2001 and 2001/2002 seasons at two sites, namely, Sanhi and Mufambi. Five weeding methods that were investigated include: no-weeding (check); hand weeding; hand weeding at 2 and 6 weeks after transplanting; ridge re-moulding at 3 WAT and hand weeding on the ridge 6 and 9 WAT; Lasso (alachlor) at 4 l/ha applied over ridge top immediately after transplanting; Ronstar (oxidiazinon) at 2 l/ha tank mixed with Lasso at 2 l/ha applied 24 h prior to transplanting of seedlings. All herbicides were applied using a 15-litre capacity knapsack sprayer fitted with a flat fan nozzle. The herbicide-water solution was applied at the rate of 200 l/ha.

The treatments were laid out in a randomised complete block design (RCBD) with three replications; each plot measuring 4.5 x 5 m comprised of five rows, resulting in a gross plot size of 22.5 m^2. Of the gross plot, two outer paprika rows i.e. one from either side, plus 0.6 m on both sides of the plot length were discarded, thus giving a net plot size of 10.26 m^2 from which all the data records were collected. Paprika seedlings were raised in a standard nursery for 8 weeks before they were transplanted onto the field. Transplanting was done when seedlings were 10–15 cm in height. Transplanting of paprika was done on ridges with inter- and intra-row spacing of 0.9 m and 0.2 m, respectively, to give a theoretical plant population of 55 550 plants per hectare. Compound "L" fertilizer (7% N, 14% P_2O_5, 7% K_2O) was applied at 1 000 kg/ha before transplanting. Ammonium nitrate (34.5% N) was top-dressed in 2 splits at the rate of 350 kg/ha at 4 and 8 WAT. Muriate of potash (65% K_2O) was applied in 2 splits at the rate of 350 kg/ha also at 4 and 8 WAT. Disease severity data were collected fortnightly beginning 2 WAT till harvest. Weed density data were collected at 5 and 8 WAT. Weed data were collected from the area defined by a 0.3 x 0.3 m quadrant. The quadrants were thrown randomly three times in the gross plot. Using identification aids, weeds were identified to species level. Diseases were identified by the use of coloured visual aids showing diseases and symptoms on paprika (Paprika Zimbabwe 1998). Diseased plant samples of both paprika and weeds were collected from the field and taken to the Plant Pathology laboratory at the University of Zimbabwe where identification and confirmation through laboratory tests were carried out. Disease severity data were collected using a scoring scale of 0–5, where 0 represents no disease, 1 – very low severity, 2 – low severity, 3 – moderate severity, 4 – high severity, 5 – very high severity/ plant dead. The disease severity data were then used to calculate the area under disease progress curves (AUDPC) by the trapezoidal integration programme of a Sigma Plot 2000 computer package. Yield data were collected at 18 WAT and subjected to analysis of variance. The economic analysis was carried out to compare the profitability of treatments according to the procedure described by CIMMYT (1988) and the modified method of Ward *et al.* (1997). The economic analysis was only carried out on data that had significant differences on marketable fruit yield.

The gain in marketable yield (G) due to weeding treatment is the difference between yield with weeding treatment (Yc) and yield of the non-weeded treatment (Yo), as shown in equation (i):

$$G = Yc - Yo \qquad \text{(i)}$$

The added profit to weeding treatment (Pa) was calculated from the gain in yield (G) multiplied by the paprika price per tonne (R) less the costs of weeding (F), weeding operation (A) and the extra cost of harvesting the gain in yield (H), as shown in equation (ii):

$$Pa = (G \times R) - (F + A + H) \qquad \text{(ii)}$$

Added profit (Pa) reflects the estimated economic benefits of weeding as it shows the extra income less increased costs associated with weeding treatment.

RESULTS

Weed assessment

Black jack (*Bidens pilosa*), stinkblaar (*Datura stramonium*) and apple of Peru (*Nicandra physalodes*) were major weeds observed in paprika fields at both sites during the two seasons. Apple of Peru was predominant at the Sanhi site and Stinkblaar was highly associated with the occurrence of powdery mildew and leaf spots in both seasons and sites.

Weed density

Weed density in the 2000/2001 season was not significantly ($p \leq 0.05$) different for both sites, Sanhi and Mufambi (Table 1). In the 2001/2002 season weed density at 5 WAT was not significant. Hand weeding and herbicide application treatments had the same effects on weed density at 17 WAT for both sites.

Disease assessment and severity

The major diseases that were identified consistently over the two seasons were bacterial leaf spot (*X. campestris* pv. *vesicatoria*), cercospora leaf spot (*C. unamunoi*), grey leaf spot (*S. solani*) and powdery mildew (*L. taurica*). Ridge re-moulding at 3, 6 and 9 WAT had the least AUDPC at the Mufambi site in the 2000/2001 season. There were no significant differences in AUDPC at Sanhi in the 2000/01 season (Table 2). The least AUDPC was recorded from ridge re-moulding at 3, 6 and 9 WAT at the

Mufambi site in the 2001/2002 season. The least AUDPC was recorded in plots which received Ronstar-Lasso tank, Lasso, and ridge re-moulding at 3, 6 and 9 WAT at the Sanhi site in the 2001/2002 season (Table 2).

Table 1. Effect of weed control method on weed density [number/m^2] in paprika at Sanhi and Mufambi, Zimbabwe in 2000/2001 and 2001/2002 seasons

Weeding control treatment	2000/2001		2001/2002		2001/2002	
	Weed density 5 WAT				Weed density 8 WAT	
	Sanhi	Mufambi	Sanhi	Mufambi	Sanhi	Mufambi
Re-ridging at 3, 6 & 9 WAT	88.1d	11.3	108.6	21.9d	74.1b	37.2
Hand weeding at 2 & 6 WAT	675.1a	88.1	274.4	153.9b	67.6b	33.9
Lasso after transplanting	337.8b	40.7	130.8	59.3c	93.3b	31.6
Lasso & Ronstar tank	222.9bc	45.8	107.2	60.7c	58.9b	26.9
No weeding (Check)	150.3c	63.6	251.2	457.1a	199.5a	63.1
SE±	0.064	0.269	0.100	0.106	0.078	0.127

*Means within a column having letters in common do not differ significantly according to Duncan's multiple range test ($p < 0.05$)

Table 2. Effect of weed control method on disease severity (AUDPC) and marketable fruit yield in paprika at Sanhi and Mufambi, Zimbabwe in 2000/2001 and 2001/2002 seasons

Weeding treatment	2000/2001		2001/2002		2000/2001		2001/2002	
	Area under disease progress curve (AUDPC)				Total marketable yield [t/ha]			
	Sanhi	Mufambi	Sanhi	Mufambi	Sanhi	Mufambi	Sanhi	Mufambi
Re-ridging at 3,6 & 9 WAT	21.27	23.27c*	31.97bc	21.07c	0.03	0.39	0.13a	0.18ab
Hand weeding at 2 & 6WAT	24.07	25.73bc	35.4b	28.67	0.06	0.12	0.13a	0.20a
Lasso after transplanting	23.07	34.73a	30.37c	27.17bc	0.01	0.11	0.02b	0.15ab
Lasso & Ronstar mix	23.53	28.00b	31.5bc	30.2b	0.01	0.04	0.02b	0.13b
No weeding (Check)	22.87	28.27b	46.5a	51.93a	0.01	0.03	0.02b	0.01c
SE±	1.1249	1.047	1.464	1.931	0.021	0.078	0.021	0.184

* Means within a column having letters in common do not differ significantly according to Duncan's multiple range test ($p < 0.05$)

Total marketable yield

In the 2000/2001 season there were no significant differences ($p \leq 0.05$) in total marketable fruit yield for both sites (Table 2). At Sanhi in the 2001/2002 season the highest mean marketable fruit yield was achieved by either hand weeding at 2 and 6 WAT or ridge re-moulding at 3, 6 and 9 WAT. At Mufambi, the highest mean marketable yield was achieved by hand weeding at 2 and 6 WAT although ridge re-moulding at 3, 6 and 9 WAT and Lasso application one day after seedling transplanting also gave significantly ($p \leq 0.05$) similar fruit yields.

Economic analysis

Yield gain

Ridge re-moulding at 3, 6 and 9 WAT or hand weeding at 2 and 6 WAT gave significantly ($p < 0.05$) the greatest yield gain at Sanhi site in 2001/2002 season (Table 3). The least yield gain in 2001/2002 season at Sanhi site was achieved by the application of Lasso and Lasso-Ronstar tank treatments. On the other hand, even though there were significant ($p < 0.05$) differences in the total marketable fruit yields, yield gain was not significantly different ($p > 0.05$) at the Mufambi site in the 2001/2002 season (Table 4).

Table 3. Marketable paprika fruit yield [t/ha] and added profit for different weed control methods at Sanhi, Zimbabwe in 2001/2002 season

Weed control method	*SAUDPC	Actual marketable yield [t/ha]	Yield gain over non-weeded [t/ha]	Added profit [Z$'000 [1]/ha]
Re-ridging at 3, 6 and 9WAT	2.664bc	0.127a	0.103b	20.172a
Hand weeding at 2 and 6WAT	2.95b	0.127a	0.103b	23.205a
Lasso at 4 L/ha after transplanting	2.531c	0.024b	0a	(10.684)b
Lasso-Ronstar mix	2.625bc	0.02b	(0.004)a	(8.945)b
No weeding (Check)	3.875a	0.024		
SE±	0.155	0.232	0.024	8.732

*SAUDPC is the area under disease progress curve, standardised by dividing AUDPC by the time duration (weeks) of disease epidemic. Added profit equals gain in yield multiplied by paprika price per tonne less costs of herbicide/weeding operation, herbicide application (where applicable) and harvest cost of yield gain

Means within a column having letters in common do not differ significantly according to Duncan's multiple range test ($p < 0.05$)

[1]1US Dollar = Z$5 500. at the time the research work was done

Table 4. Marketable paprika fruit yield [t/ha] and added profit for different weed control methods at Mufambi, Zimbabwe in 2001/2002 season

Weed control method	*SAUDPC	Actual marketable yield [t/ha]	Yield gain over non-weeded [t/ha]	Added profit [Z$'000[1]/ha]
Re-ridging at 3, 6 and 9WAT	2.517b	0.18 ab	0.17	40.272
Hand weeding at 2 and 6WAT	2.389b	0.2a	0.19	50.305
Lasso at 4 L/ha after transplanting	2.264bc	0.15ab	0.14	37.653
Lasso-Ronstar tank mix	2.517b	0.13b	0.12	29.054
No weeding (Check)	4.328a	0.01c		
SE±	0.204	0.023	0.031	5.242

* SAUDPC is the area under disease progress curve, standardised by dividing AUDPC by the time duration (weeks) of disease epidemic. Added profit equals gain in yield multiplied by paprika price per tonne less costs of herbicide/weeding operation, herbicide application (where applicable) and harvest cost of yield gain

Means within a column having letters in common do not differ significantly according to Duncan's multiple range test ($p < 0.05$)

[1] 1US Dollar = Z$5 500. at the time the research work was done

Added profit

The highest added yield profit of Z$23 205/ha was obtained by hand weeding at 2 and 6 WAT, which was significantly the same as Z$20 172/ha achieved by re-ridging at 3, 6 and 9 WAT at Sanhi site in 2001/2002 rainy season (Table 3). Application of Lasso and Lasso-Ronstar treatments resulted in significantly the same losses at Sanhi site in 2001/2002 of Z$10 684/ha and Z$8 945/ha, respectively. Added profits were not significantly ($p > 0.05$) different at Mufambi site in the 2001/2002 season. However, the least added profit of Z$29 054/ha achieved at Mufambi site in 2001/2002 season was better than the highest achieved at Sanhi site (Z$23 205/ha) in the same season (Table 4).

DISCUSSION

The differences in weed spectrum per site resulted in differences observed as the effect of different weeding methods. Of note is the occurrence of highly ranked stinkblaar at Sanhi site in both seasons. Santin (2001) reported that growth and fruit yield of tomato and (much so) peppers were very sensitive to the pressure of *D. stramonium* and this resulted in the damage from its more intense and earlier competitive capacity for environmental resources. Stinkblaar is a very persistent weed in paprika and highly regarded as a major threat as far as weed management is concerned in paprika production (Paprika Zimbabwe 1998). In addition, this weed is usually associated with the high occurrence possibilities of powdery mildew and leaf spots, thus negatively affecting paprika quality. Even then, weeds generally constitute a major yield-limiting concern for paprika production in the Chinyika Resettlement Area (Chivinge and Mariga 2000). Hand weeding and ridge re-moulding ensured the effective control of weeds, including obnoxious stinkblaar, as it involves the elimination of the germinating and already emerged weeds. Lanini and Le Strange (1994) noted that weeds were small and easy to remove when hand weeded at 2-week intervals, but were well rooted and difficult to remove if 4 weeks elapsed between weedings. Bell pepper was especially sensitive to root disturbances with the removal of large weeds and this resulted in injury or even death of some plants. Consistency in performance of hand weeding treatments, which had intervals ranging from 3 to 4 weeks in the present investigation, suggests that a 3-week interval is probably as ineffective as the 4-week interval.

The first season was very dry, with transplanting done as late as January; hence the effects of weed spectrum and density were not different as the field had to be re-prepared in January. Weeds that had germinated earlier due to very little rain received in late October were controlled during the land re-preparation operation, thereby reducing the weed pressure. Stinkblaar had a lower severity level of powdery mildew and leaf spots in 2000/2001 than in 2001/2002 season. This was attributed to a low disease incidence arising from the generally dry weather that prevailed during that season.

In the second season, Lasso had the same effect as hand weeding, probably due to the fact that the second season was relatively wetter than the preceding one and hence seedling transplanting was done at an earlier date. Furthermore, it had rained lightly some hours after the Lasso application, as if to fulfill the requirement of a light irrigation after the application of the herbicide (Paprika Zimbabwe 1998). This must have provided favourable conditions for Lasso application and effectiveness. However, the prices of herbicides also reduced the added profits more than the hand weeding operation. It must be noted that after the first season of the experiment following recommended application of the herbicides only at the beginning of the season, it was felt that in addition to the herbicide application, supplementary hand weeding had to be done at 8 WAT in order to save the crop from the menacing effect of weeds. Several workers (Orsenigo and Ozaki 1965; Americanos 1976; Uwannah 1982) had earlier reported effective weed control and high pepper fruit yields with grass-weed potent herbicides such as alachlor (Lasso), oxadiazon (Ronstar), diphenamid, metolachlor and pendimethalin. On the other hand, the consistency of hand weeding over the 2000/2001 and 2001/2002 seasons in CRA is similar to the findings at Samaru, Nigeria of Adigun *et al.* (1987), who reported that two and three hoe weedings resulted in comparable pepper fruit yields in the wet and dry seasons, suggesting that any weeding done at 6 WAT as a supplementary operation to either hoe weeding or pre-transplant herbicide application would be adequate for effective weed control in pepper.

Generally, the marketable fruit yields that were achieved during the two seasons of our field research were lower than normal. Lanini and Strange (1994) reported similarly that lack of irrigation water in 1990 prevented crop development after the first harvest; consequently, both total yield and net return were reduced. This resulted in yields that were lower than the ones associated with the smallholder paprika farmers. The average paprika yield for the smallholder paprika farmers under dryland production in a normal wet season is about 0.7 t/ha (The Herald 2002). The low marketable yields were attributed to very low rainfall received in 2000/2001 and 2001/2002 rainy seasons. The higher levels of added profits achieved at Mufambi site as compared to the Sanhi site could be attributed to high marketable yield achieved at the former site. This may be partly explained by the lower occurrence of *D. stramonium*, which was very predominant at the Sanhi site. Santin (2001) suggested that in order to avoid loss of fruit yield due to the presence of *D. stramonium*, this weed species should be controlled between the 4-and 8-leaf stages of the pepper crop. The association of *D. stramonium* and powdery mildew may also have contributed to the observed yield reduction. Hand weeding operation was very effective and consequently gave the highest added profits, mainly because of its effectiveness on major weeds such as *D. stramonium*. Herbicides did not effectively control *D. stramonium*. Since *D. stramonium* was not very prevalent at Mufambi site, the effectiveness of the herbicide treatments improved to the level of hand weeding operation. This resulted in herbicide and hand weeding treatments being significantly ($p > 0.05$) at par at the Mufambi site in the 2001/2002 season.

CONCLUSIONS

Hand weeding operation gave the best added profits in fields with *D. stramonium*. Smallholder paprika farmers can hand-weed either at 2 and 6 WAT or 3, 6 and 9 WAT in areas predominated by the weed *D. stramonium* for the best economic benefits. In areas having low level of *D. stramonium* infestation, farmers can choose between hand weeding and herbicide weed control. Under low weed pressure, smallholder paprika farmers can therefore hand weed at 2 and 6 WAT or remould ridges at 3, 6 and 9 WAT for effective weed management. Use of the herbicide Lasso at 4l/ha is very effective when combined with one supplementary hand hoe weeding between 6 and 8 WAT. Effective weed management was associated with low disease severity, implying that weeding can go a long way in the enhancement of an effective disease management. Paprika could be grown profitably without the use of herbicides for weed control; but when herbicides are used, one supplementary hand weeding between 5–6 WAT would be necessary. When availability and cost of labour during the typical paprika growing season are limiting, the use of herbicides and a supplementary hand weeding may be the best option.

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POLISH SUMMARY

PORÓWNAWCZE STUDIUM WPŁYWU STRATEGII ZWALCZANIA CHWASTÓW NA NASILENIE CHORÓB I PLON HANDLOWY PAPRYKI (*CAPSICUM ANNUUM* L.) W DROBNOTOWAROWYM SEKTORZE ROLNYM W ZIMBABWE

Badania prowadzono w gospodarstwach rolnych suchego regionu Chinyika Rosettlement w Zimbabwe. Prowadzone prace miały na celu porównanie wpływu różnych metod zwalczania chwastów na występowanie i nasilenie chorób oraz na plon owoców papryki. Stosowano następujące zabiegi zwalczania: pielenie ręczne 2 i 6 tygodni po wysadzeniu Roślin; obredlanie wtórne Roślin 3, 6 i 9 tygodni po sadzeniu; zastosowanie opryskiwania preparatem Lasso (alachlor) w dawce 4l/ha (…. składnika aktywnego/ha) bezpośrednio po sadzeniu; zastosowanie preparatu Ronstar (oxidiazinon) w dawce 2l/ha (…składnika aktywnego/ha) zmieszanego w zbiorniku opryskiwacza z preparatem Lasso w dawce 2l/ha na 1 dzień przed sadzeniem. Zabiegi wykonywano opryskiwaczem plecakowym zużywając na hektar 200l roztworu wodnego preparatów. Głównymi zidentyfikowanymi w obydwóch latach badań chorobami były: bakteryjna plamistość liści (*Xanthomonas campestris* pv. *vesicatoria*), szara plamistość liści (*Stemphylium solani*) i mączniak prawdziwy (*Leveillula taurica*). W sezonie 2000/2001 największy ograniczający wpływ na powierzchnię pod krzywą postępu chorób (AUDPC), plon handlowy i występowanie chwastów miało ręczne pielenie 2 i 6 tygodni po sadzeniu roślin, oraz obredlanie wtórne 3, 6 i 9 tygodni po sadzeniu. W sezonie 2001/2002 obydwa zabiegi herbicydowe miały taki sam wpływ na AUDPC oraz na plon handlowy papryki, jak pielenie ręczne i obredlanie wtórne. Najmniejszą gęstość występowania chwastów stwierdzono w przypadku obredlania wtórnego w sezonie wegetacyjnym 2001/2002, 3, 6 i 9 tygodni po sadzeniu. Gęstość występowania chwastów była statystycznie taka sama we wszystkich kombinacjach doświadczalnych, z wyjątkiem kombinacji kontrolnej. Pielenie ręczne było statystycznie istotne ($p < 0,05$) i w konsekwencji przyczyniło się do uzyskania najwyższego sumarycznego zysku, głównie z powodu skuteczności przeciw najważniejszym chwastom, takim jak *Datura stramonium*.