Pak. J. Weed Sci. Res. 9(1-2) 105-110, 2003

CHEMICAL WEED CONTROL EFFICIENCY IN POTATO *(SOLANUM TUBEROSUM L.)* UNDER AGRO-CLIMATIC CONDITIONS OF PESHAWAR, PAKISTAN

Saima Hashim[1], Khan Bahadar Marwat[1] and Gul Hassan[1]

ABSTRACT

An experiment consisting of eight treatments, viz., no-weeding, Stomp 330f (pendimethalin), Igran 500FW (triazine), Authority 4F (sulfentrazone), Topogard 500FW (triazine + terbuthylazine), Sencor 70WP (metribuzin) and Treflan 4EC (trifluralin) was conducted in RCB design at Malakander Farm, NWFP Agricultural University, Peshawar during Fall 2001 to see the impact of treatments on potato and its weeds. Weeds' dry matter was highest in no-weeding (486.4 g/m^2) followed by Treflan (444.4 g/m^2), both statistically at par, whereas statistically lowest dry matter (273.1 g/m^2) was found in hand-weeding. Crop height was maximum (28.64 cm) in hand-weeding but statistically at par with other treatments, except Treflan (18.56 cm) where plant height was lowest. Number of tubers did not differ significantly, though the number was otherwise higher in Sencor (266941) and Topogard (264500) compared with other treatments. Potato yield was statistically highest in hand-weeding (14729 kg/ha) followed by Topogard (14486 kg/ha) and Sencor (14219 kg/ha), respectively, however, these treatments were statistically at par with each other. The remaining treatments resulted in statistically lower yield and were statistically at par with each other.

INTRODUCTION

Potato is a member of the family *Solanaceae* having several hundred species in the genus *Solanum*, but only *S. tuberosum*, the potato, a native of South America and a few others is tuber bearing. Potato is the world's leading vegetable crop and is grown in 79% of the world's countries (FAO, 1986). It is second to maize in terms of the number of producer countries and fourth after wheat, maize and rice in global tonnage. The average composition of the potato is about 80 per cent water, 2 per cent protein, and 18 per cent starch. As a food, it is one of the cheapest and easily available source of carbohydrates and proteins and furnishes appreciable amount of vitamins B and C as well as some minerals. Moreover, protein of potato is of high biological value (Woolfe, 1987, Gandapur 1995). In one form or another, there can hardly be any table in the world where this vegetable is not served as a food item (Ivins & Milthope, 1963; Horton, 1987).

Potato is becoming increasingly important crop, as it is one of the best alternatives to meet the growing food needs of the large population of the developing countries. Accredited to its short duration, nutritional superiority and high amount of food per unit area and time, potato production in developing countries has been increased by about 25% over the last 4 decades. According to the estimate of International Food Policy Research Institute (IFPRI) and International Potato Center (CIP) worldwide demand of potato is expected to increase by 40% during 1993-2020 (Khurana, 2002).

A total of about 1.5 million tonnes of potato is produced at national level in Pakistan, with a national average of 14.6 tonnes per hectare, whereas NWFP shares about 120000 tonnes (Anonymous, 2001). Based on 38% yield losses in potato, about Rs.3.9 billion is lost due to weeds annually.

Department of Weed Science, NWFP Agricultural University, Peshawar-25130, Pakistan.
E-mail: kbmarwat@yahoo.com

(Marwat, 2001). According to Ashraf (1988), potato yield was increased by 2.8 times of control due to weeding. According to Malik (1995), *Orobanche aegyptiaca* (broomrape) a parasitic weed of Potato, cause upto 30% yield loss in potato. Moreover weeds significantly reduce yield of potato and hinder removing of tubers (Knezevic, et al., 1995). According to Jaiswal and Lal (1996a; 1996b), weeds reduce the tuber yield by 42% on the average, whereas weed control treatments increase the tuber yield by 18-82%. This scenario calls for the concerted efforts to capture the available resources to their best to allow the potato crop to meet the production target under the scarcity of arable land, water and other environmental stresses. It is a high time to increase potato productivity from the area, which is already under cultivation, but is underutilized, which is the main setback faced by the country. In true sense our cultivated lands are contaminated by wide range of pest plants, which result in the both biotic and abiotic stresses directly or indirectly leading to low output, no matter whatever supreme quality inputs like good seed, fertilizer etc, can only be targeted to high potato production if the weed that enjoy the resources un-served to them are managed wisely. Unless and until we manage the weed in our field all our efforts for higher production including natural resources like land, water, sunlight and inputs all go target less. Our potato crop can only be able to enjoy our attention and care if it is not in stress due to competition with weed

Keeping these losses in mind and substantial returns after weed control, an experiment was conducted to evaluate Potato *var. Cardinal* against different herbicides on weeds' biomass and potato yield and its components

METHODS AND MATERIALS

The experiment was conducted on weed control in potato *var. Cardinal* using Randomized Complete Block Design (RCBD), having eight treatments (Table 1) and five replications. Sowing was done on a well-prepared soil on September 20, 2001 at Malkandher Research Farm, NWFP Agricultural University, Peshawar. Each treatment consisted of 3 ridges, 5 meter long, having row-to-row distance of 75 cm and plant-to-plant distance of 20 cm. Thus, a total of 75 tubers (25 per ridge) were assigned to each treatment. Treflan was pre-plant incorporated while other herbicides except Sencor were used as pre-emergence on the same day soon after sowing, while Sencor was applied 15 days after sowing of potato, when tubers had sprouted.

Table 1. Treatments along with their formulations used in the experiment.

Treatment/Trade Name	Common Name	Commercial Product L/kg ha^{-1}	Active ingredient kg ha^{-1}
No weeding	----------	----------	----------
Hand weeding	----------	----------	----------
Stomp 330E	pendimethalin	4.0	1.32
Igran 500FW	atrazine	1.5	0.75
Authority 4F	sulfentrazone	1.5	0.60
Topogard 500FW	atrazine+terbuthylazine(35:15)	1.5	0.75
Sencor 70WP	metribuzin	0.6	0.42
Treflan 4EC	trifluralin	3.0	1.20

While preparing soil, 'P' & 'N' were applied at the rate of 100 and 200 kg ha^{-1}, where all P and half N were applied at the time of soil preparation and incorporated into the soil, the remaining half N was applied before earthing-up, and mixed with the soil. Earthing-up was done four weeks after sowing. Weeds data were collected four times at three weeks intervals, starting two weeks after earthing-up. For control of blight and insects, mancozeb 80WP (fungicide) and cypermethrin 10EC (insecticide) were sprayed twice. Irrigation and other agronomic practices were carried out as per requirement of the crop. Data collected were analyzed statistically using Analyses of Variance (ANOVA) procedure and means were separated using LSD test (Steel and Torrie, 1980). Yield was

regressed with the various parameters studied to establish relationship of the respective parameter with the tuber yield.

RESULTS AND DISCUSSION

As a whole the crop was not very healthy as it was attacked by Early blight (*Alternaria solani*), however, the infestation was uniform, therefore, the relative effect of weed control treatments on different parameters was consistent. Data were collected on weeds dry matter m^{-2}, plant height (cm), number of tubers ha^{-1} and tuber yield (kg ha^{-1}), which is explained and discussed as follows

Weeds dry matter (g m^{-2})

Weeds' dry matter was significantly affected by treatments (Table 2). After applying LSD at alpha 0.05 the highest weeds' dry matter of 486.52 g m^{-2} was found in no weeding followed by Treflan 4E having dry matter of 444.44 g m^{-2}, both were similar statistically. The lowest dry matter of 273.12 g m^{-2} was found in hand weeding. The effect of remaining treatments viz. Stomp 330E, Igran 500 FW, Authority 4F, Topogard 500 FW and Sencor 70 WP was statistically similar and somewhere in between the two extremes as reported earlier (Table 3). According to Sawicka & Skalski (1996), weeds' dry matter was lowest in mechanical weeding (corresponding with hand weeding in this case) and Sencor compared to other treatments in their study are analogous to our findings. Eberlin et al (1997) reported weed biomass reduction in the range of 98 to 99% relative to weedy check while applying Stomp and Sencor. When weeds' dry matter was correlated with potato yield, the correlation was negative and highly significant (P=0.001), indicating that with increase in weeds dry matter there is decrease in yield (Table 4).

Table 2. Mean squares for various parameters studied as affected by weed control treatments.

Source	DF	MS for Weeds' dry matter	MS for Plant height	MS for No. of tubers ha^{-1}	MS for potato yield
Replication	4	14157.22**	212.02**	4084786610**	2543239*
Treatments	7	23020.09**	48.16**	776231358	7564162.5**
Error	28	1359.68	9.36	1032929435	807652
CV%		9.98	12.13	12.72	9.15

* Significant at alpha = 0.05 ** Significant at alpha = 0.01

DF = Degrees of freedom; MS= Mean square

Plant Height (cm)

As depicted in Table 2, the treatment effect on plant height was highly significant. Means were subjected to means separation test (LSD), which revealed that plant height was the maximum in hand-weeding (28.64 cm) and minimum in Treflan (18.56 cm). Authority and Sencor were somewhere in the middle, which resulted in plant height of 24.62 and 24.19 cm, respectively. The remaining treatments, viz., no weeding, Stomp, Igran and Topogard, resulted in a plant height of 26.98, 27.21, 24.78 and 26.85 cm, respectively which were statistically similar among themselves (Table 3). Plant height when compared with corresponding weeds and yield; yield was highest in hand-weeding, where plant height was maximum compared to other treatments. Similarly plant height was minimum in Treflan and its corresponding yield was also next minimum after no weeding. This indicates, the greater is the plant height, higher is the tubers yield and vice versa (Table 4). Although the correlation is positive, but statistically non-significant.

Number of tubers ha^{-1}

The treatment effect on number of tubers was statistically non-significant (Table 2), but even then the means were subjected to non-protected LSD. Yet the differences were not evident/not different statistically. However, maximum number of tubers (266941 ha^{-1}) were found in Sencor, and minimum number of tubers (233235 ha^{-1}) were found in Treflan (Table 3). Since tuber number is

not significantly different among the treatments, therefore it is difficult to correlate it with weeds and potato parameters, specially yield. The correlation of tubers with yield is positive, but statistically not significant (Table 4). This indicates that the potential of tubers production was genetically controlled and was not affected by the treatments. Since potato yield is independent of number of tubers, therefore, yield depends upon the size of tubers rather than the number of tubers. though the number of tubers were highest in Sencor (266941 ha^{-1}) and Topogard (266500 ha^{-1}), respectively, however statistically not different from other treatments.

Yield (kg ha^{-1})

Yield was significantly affected by treatments (Table 2). While comparing the treatment means, hand-weeding gave highest yield of 14729 kg ha^{-1}, whereas lowest yield of only 5984 kg ha^{-1} was found in no-weeding. Interestingly Hand-weeding, Topogard and Sencor were at par statistically yielding 14729, 14486 and 14219 kg ha^{-1}, respectively. Similarly no-weeding, Stomp, Igran Authority and Treflan were statistically at par with one another resulting in a total yield of 5984 7393, 7559, 7110 and 7060 kg ha^{-1}, respectively (Table 3). As far as yield is concerned; effect of Hand-weeding, Topogard and Sencor was statistically at par. The higher yield in hand-weeding perfectly coincides with corresponding lowest weeds' dry matter and plant height. The higher yield of Topogard and Sencor also attributes to the similar response of aforementioned parameters. Low potato yield and high weeds' dry matter are again indicative of high weeds density in no-weeding. From perusal of Table 3, it is also evident that low weeds dry matter and plant height resulted in higher yield. Chirita (1995) has reported 87% weed control and 14% yield increase with Sencor+Frontier 900 compared to weedy check, whereas Guttieri & Eberlein (1997) has reported yield increase with application of rimsulfuron+ metribuzin (Sencor). Similarly Tyla & Tamosiunas (1996) and Ackley (1996) reported yield increase due to use of Sencor.

Based on the overall higher potato yield three treatments, viz. hand-weeding, Sencor and Topogard proved to be the best ones and statistically at par with one another. Therefore, wherever socio-economic and agronomic conditions are permissive, hand-weeding may be supplemented with one of these herbicides i.e. Topogard and Sencor to maximize potato yields.

Table 3. Effect of weed control treatments on weeds' dry matter (g m^{-2}), plant Height (cm), number of tubers ha^{-1} and tubers yield (kg ha^{-1}).

Treatments	Weeds Dry Matter (g m^{-2})	Plant Height (cm)	Number of tubers ha^{-1}	Tubers yield kg ha^{-1}
No-weeding	486.5 A	26.98 AB	242234	5984 B
Hand weeding	273.1 C	28.64 A	240605	14729 A
Stomp	339.0 B	27.21 AB	259216	7393 B
Igran	379.3 B	24.78 AB	254173	7559 B
Authority	333.2 B	24.62 B	260787	7110 B
Topogard	365.6 B	26.85 AB	264500	14486 A
Sencor	333.9 B	24.19 B	266941	14219 A
Treflan	444.4 A	18.56 C	233235	7060 B
LSD (alpha 0.05)	47.95	3.96	Non significant	6161

Table 4. Correlation coefficients, T-value and Probability of Weeds dry matter, crop height and number of tubers regressed/correlated with tuber yield.

Variables	Correlation coefficients	Student's T-value	Probability
Weeds' dry matter	- 0.498	3.538	0.001
Crop height	+0.140	0.874	0.387
No. of Potato tubers	+0.138	0.861	0.394

REFEFRENCES CITED

Ackley, J.A., H.P. Wilson and T.E. Hines. 1996. Efficacy of rimsulfuron and metribuzin in potato (*Solanum tuberosum*). Weed Tech. 10 (3): 475-480.

Anonymous, 2001. Agriculture Statistics of Pakistan. MINFAL, Islamabad.

Ashraf, M. 1988. Magnitude of weed problem in vegetables, pp.278-288 in R.A.Shad and M.S.K Rana (ed.). Improved Weed Management. NARC, Islamabad.

Chirita, N. 1995. Research on the selectivity of some herbicides in controlling annual weeds in a potato crop. Cercetari Agronomice in Moldova. 28 (3-4): 123-126 (Romanian).

Eberlein, C.V., B.A. King, M.J. Guttieri, P.C. Robert, R.H. Rust and W.E. Larson. 1999 Proc. 4th Inter. Conf. on Precision Agriculture, St. Paul, Minnesota, USA, 19-22. July 1998. Part A and Part B.1999, 869-877.

FAO, 1986. 1985 FAO production yearbook, Vol. 36, pp 126-7 FAO Statistics Series No. 47, Rome.

Gandapur, A.K. 1995. Evaluation of potato varieties in Hazara. M.Sc. (Hons) Thesis, Department of Plant Breeding and Genetics, NWFP Agricultural University, Peshawar.

Guttieri, M.J. and C.V. Eberlein. 1997. Preemergence weed control in potatoes (*Solanum tuberosum*) with rimsulfuron mixtures. Weed Tech. 11(4): 755-761.

Horton, D. 1987. Potatoes: Production, Marketing, and Programs for Developing countries. pp 244 Westview Press.

Ivins, J.D. and F.L. Milthope. 1963. The growth of potatoes. pp 328. Butterwoyhs (London).

Jaiswal, V.P. and S.S. Lal.1996a. Efficacy of cultural and chemical weed control methods in potato. J. Indian Potato Assoc. 23(1-2): 20-25.

Jaiswal, V.P. and S.S. Lal.1996b. Efficacy of cultural and chemical weed-control methods in potato (*Solanum tuberosum*). Indian J. Agron. 41(3): 454-456.

Knezevic, M., M. Durkic and D. Samota. 1995.Chemical and mechanical weed control in potatoes Fragmenta Phytomedica et Herbologica 1995, 23(2): 61-67 (Croatian).

Malik, N.J. 1995. Potatoes in Pakistan. A Handbook. PSPD Project, Pakistan Agricultural Research Council, PO Box 1031. Islamabad, Pakistan.

Marwat, K.B. 2001. Yield losses in major crops due to weeds. Facts sheet 2001. Department of Weed Science, NWFP Agricultural University, Peshawar.

Sawicka, B. and J. Skalski. 1996. Potato overgrowth with weeds after the use of Sencor 70 WP. Part I. Herbicide efficiency for weed control. Roczniki Nauk Rloniczych. Seria A, Produkcja Roslinna. 1996, 112(1-2): 169-182 (Polish).

Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. A biometrical Approach. Second Edition. McGraw Hill, Inc. USA.

Tyla, G. and A Tamosiunas. 1996. Combination of mechanical and chemical means for weed control in different potato varieties. Lietuvos Zemdirbystes Instituto Moksło Darbai, Zemdirbyste. 1996, No. 52, 202-213 (Lithuanian).

Woolfe, J.A. 1987. The potato in the human diet. Pp. 231 Published in collaboration with International Center, Cambridge University Press.