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# STUDIES ON EFFICACY OF DIFFERENT HERBICIDES AGAINST WEEDS IN POTATO CROP IN PESHAWAR

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**Abstract**

Prevention of weed–crop competition at an early stage plays a very important role. Potato is grown abundantly in our country and particularly in Khyber Pakhtunkhwa province, but due to lack of proper attention potato yield is always very low as compared to the developed countries. Regardless of other factors, weeds are one of the serious obstacles in producing higher yields. In this context, an experiment was designed in which there were a total of nine treatments including eight herbicides and a weedy check for comparison. Metribuzin 70% WP (metribuzin) @ 0.63 kg, Gramoxone 200SL + Dual gold 960EC (gramoxone+s-metolachlor) @ 3.75L+2.5L, Sencor 70WP (metribuzin) @ 0.63 kg, Torrent 50WDG (terbutryn+terbuthylazine) @ 1.75kg, Solanum 500SC (terbutryn+terbuthylazine) @ 1.75L, Dual gold 960EC (s-metolachlor) @ 2.5L, Multiquat 200SL (gramoxone) @ 3.75 L, and Gramoxone 200SL (gramoxone) @ 3.75L $ha^{-1}$ were the herbicidal treatments that were evaluated. The results revealed that all the herbicides had a significant effect on weed density $m^{-2}$ and also on tuber yield of potato. Herbicidal treatments significantly reduced the weed population as compared to the control treatments, with 104 weeds $m^{-2}$. All the treatments resulted in more than 80% mortality of the weeds that infested the field before application of the herbicides. No crop injury was observed in any of the herbicides used in the experiment. The herbicide combination, Gramoxone+Dual gold gave the highest potato tuber yield (15910 kg $ha^{-1}$) which was 36% higher than the weedy check treatments (10162 kg $ha^{-1}$). However, it was statistically similar to Gramoxone and Multiquat treatments that resulted in tuber yield of 15288 and 15022 kg $ha^{-1}$, with percent increase as 33.53 and 32.35%, respectively. Therefore, Gramoxone+Dual gold was the best treatment in the experiment for effective weed control and profitable tuber yields of potato crop in agro-ecological conditions of Peshawar.

## Introduction

After maize, potato is the most widely distributed crop in the world. It is grown in about 140 countries, more than hundred of which are located in the tropical and subtropical zones (Awan *et al.,* 2010; Shah *et al*., 2003). However, most of the production is still concentrated in the temperate regions. Almost one third of the crop is produced in the developing countries, mainly the countries in Asia. The potato originated in the mountains of South America, where it has been an important food crop for long time. During the 19th century the potato was introduced to several tropical and subtropical countries mainly by colonists from Europe. In more recent years potato has spread to many countries with warmer and drier climates and it has become important in regions such as the plains of India, Bangladesh, Pakistan, etc. (Beukama & Enderzaag, 1990). The area and yield of potato in Khyber Pakhtunkhwa province during the 2008-09 was 9.8 thousand hectares and the production was 122 thousand tons, respectively, with an average yield of 12.2 tons $ha^{-1}$ (Anonymous, 2009). Over the years, potato has become an important crop for both farmers and consumers in Pakistan (Abbas *et al.*, 2011, 2012). It is the fourth most important crop by volume of production; it is high yielding, having a high nutritive value and gives high returns to farmers. Climatic conditions in KPK are conducive to grow all three crops of potatoes.

Weed control is one of the most important factors for a successful crop production and therefore the prevention of weed-crop competition at an early stage plays a very important role (Van-Gessel & Renner, 1990). Weed competition can reduce yield by affecting tuber size, weight, and quantity (Wall & Friesen, 1990). Weeds interfere with harvest, causing more potatoes to be left in the field and increasing mechanical injury. If a mixed population of annual weeds is allowed to compete all season with potatoes, each 10% increase in dry weed biomass causes a 12% decrease in tuber yield. The critical period for weed removal in potatoes is about 4 to 6 weeks after planting and thus weeds emerging 4 weeks after planting are suppressed by crop growth. Herbicides can reduce the number of cultivations required and enhance weed control (Nelson & Giles, 1989; Marwat *et al*., 2008; Shahzad *et al*., 2012), particularly during the early season before hilling. From the beginning of the growing season until a plant height of 25-30 cm, potato is very susceptible to weed infestation. Characteristics for the weed populations of potato are annual weeds like for example: *Amaranthus spp.*, *Chenopodium album*, *Echinochloa crus–galli*, *Stellaria* spp., *Ambrosia artemisiifolia* L. and many other weeds (Janjic *et al*., 2006). From among perennial plants, *Cirsium arvense* and *Convolvulus arvensis* cause problems. Weed control in potatoes is critical to maximize yield and tuber quality (Robinson *et al.*, 1996). Numerous authors observed a favorable impact of herbicides on the potato tuber yields as a result of eliminating weed competition (Jaiswal & Lal, 1996; Ackley *et al.*, 1996; Eberlein *et al.*, 1997; Janjic *et al.*, 2006). Relatively little information is available regarding the effectiveness and safety of herbicides for potatoes. Based on 38% yield losses in potato, about Rs.3.0 billion is lost due to weeds annually (Hassan & Marwat, 2001). Banaras (1993) reported three tons loss in potato yield due to each ton of weed biomass. Despite reducing yield of potato significantly, the weeds hinder harvesting of tubers (Knezevic *et al*., 1995). An increase of 18-82% tuber yield was deciphered due to weed management (Jaiswal & Lal, 1996). Herbicides pendimathalin, metolachlor, paraquat isoproturon and metribuzin have been tested worldwide with a successful control of prevailing weeds (Jaiswal, 1994; Yaduraju *et al.*, 1993; Bellinder *et al.*, 1996; Bellinder *et al.,* 2000).

Thus, it is imperative to manage weeds in potato because the post broadleaf weed control in potatoes using only metribuzin herbicide is limited and due to its sole use, sometimes weeds are resistant to metribuzin, which limits its use (Wall & Friesen, 1990; Robinson *et al*., 1996). So in this experiment we tried to test gramoxone, metribuzin, terbutryn + terbuthylazine, sole gramaxone and in combination with s-metolachlor and then to compare all these herbicides applied as pre and post against broad and as well as grassy weeds. The objectives of this research were to compare the efficacy of these herbicide treatments for controlling different broad and grassy weeds and to determine their effect on marketable potato yields.

## Materials and Methods

The experiment was carried out to evaluate the efficacy of different chemical molecules of both old (standard) and new (candidate) formulae for weed control in potato crop during 2009-10. The experiment was laid out in randomized complete block design having three replications. Before sowing the soil was ploughed twice with rotary plough and then harrowed after which ridges were prepared. Potato tubers' variety 'Raja' was sown in September 2009 in a plot size of 5 x 3 $m^2$ having four ridges 75 cm apart with 5m length. The plant to plant distance was kept 15 cm. The experiment was consisted of nine herbicides and a weedy check. The details of the herbicides are given in Table 1.

**Table 1. Various treatments used in the experiments.**

| Treatments (trade names) | Common Names | Application time | Rate $ha^{-1}$ |
|---|---|---|---|
| Metribuzin 70% WP | metribuzin | Pre emergence (PRE) | 0.63 kg |
| Gramoxone 200 SL+Dual gold 960 EC | gramoxone + s-metolachlor | PRE | 3.75 lit + 2.50 lit |
| Sencor 70WP | metribuzin | PRE | 0.63 kg |
| Torrent 50 WDG | terbutryn + terbuthylazine | PRE | 1.75 kg |
| Solanum 500 SC | terbutryn + terbuthylazine | PRE | 1.75 lit |
| Dual gold 960 EC | s-metolachlor | PRE | 2.50 lit |
| Multiquat 200 SL | gramoxone | Post emergence (POE) | 3.75 lit |
| Gramoxone 200 SL | gramoxone | POE | 3.75 lit |
| Control (weedy check) | --- | --- | --- |

The pre-emergence herbicides were applied one week after sowing the crop before the tuber buds emerged while the post emergence herbicides were sprayed when the weeds population reached the critical stage. The non selective contact herbicides (commonly known as gramoxone) were sprayed as post emergence directly on weeds giving protection to potato plants by covering them under a polythene plastic sheet. The data on weed density $m^{-2}$ was taken one week after the application in the pre-emergence treatments; whereas in post emergence treatment it was taken three weeks after the application. The fertilizers i.e., urea, triple super phosphate and sulphate of potash were applied @ 120 kg N, 120 kg $P_2O_5$, and 180 kg $K_2O$ $ha^{-1}$, respectively at the time of planting, except half of the nitrogen which was applied at the time of earthing-up. Earthing up was done as farmers' normal practice in the last week of November at the start of tuber initiation. All other agronomic practices were uniformly applied to all the treatments. The data on weeds were recorded by counting number of weeds in one meter length in three ridges randomly selected and then were converted to $m^{-2}$. Potato tuber data were recorded by uprooting the tuber in 3 rows of one meter length and then weighed and was converted kg $ha^{1}$.

The data recorded were analyzed statistically using analysis of variance techniques appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant (Jan *et al*., 2009).

## Results and Discussion

**Weeds flora and density $m^{-2}$:** The weed density is always a key parameter in assessing out the weeds' impact on the associated crops. In this regard, the present data on weed density $m^{-2}$ (Table 2) showed that the various herbicidal molecules have had a significant effect on the weed density $m^{-2}$. As far as the weed flora is concerned, the major weed species found in the field were *Euphorbia helioscopia*, *Anagallis arvensis, Sorghum halepense, Cyperus rotundus, Trianthema monogyna, Convolvulus arvensis* and *Digitaria sanguinalis*. Mean value of the data indicated that all herbicides significantly controlled the weed species as compared to the weedy check treatments. Among herbicides, the combination of Gramoxone 200 SL + Dual gold 960 EC reduced the weed density to 4.5 plants $m^{-2}$ i.e., 95.7% reduction in the general weed population; the treatment was however statistically at par with Gramoxone 200 SL (5.2 weeds $m^{-2}$ with 95% weed mortality) and Multiquat (5.7 weeds $m^{-2}$ with 94.5% mortality of the weeds) as compared to that in the weedy check where the highest weed density of 104 plants $m^{-2}$ was recorded. The rest of the herbicides were significantly different from the weedy check but at par with each other in terms of weed density $m^{-2}$. All the treatments resulted in more than 80% mortality of the weeds that infested the field before application of the herbicides (Table 2). Similar results on weed control with herbicides were reported by Ceglarek & Księżak (1992); Ackley *et al*., (1996); Eberlein *et al*., (1997); Zarzecka (1997); Janjic *et al*., (2006). The results are in line with Shah *et al*., (2003) and Hashim *et al*., (2003) who isolated chemicals for weed management in potato crop.

**Table 2. Mean weed density m $^{-2}$ of different weed species as affected by the weed control treatments in potato crop.**

| Treatment | *Euphorbia helioscopia* | *Anagallis arvensis* | *Sorghum halepense* | *Cyperus rotundus* | *Trianthema monogyna* | *Convolvulus arvensis* | *Digitaria sanguinalis* | Total | Percent reduction |
|---|---|---|---|---|---|---|---|---|---|
| Metribuzin 70 WP | 2.3 b | 3.0 b | 4.0 b | 3.3 b | 2.7 b | 2.00 b | 2.3 b | 19.6 b | 81.2 |
| Gramoxone 200 SL + Dual gold 960 EC | 00 b | 1.0 b | 1.5 b | 1.0 b | 00 b | 00 b | 1.0 b | 4.5 c | 95.7 |
| Sencor 70WP | 2.0 b | 2.5 b | 4.3 b | 4.5 b | 2.0 b | 2.0 b | 3.0 b | 20.3 b | 80.5 |
| Torrent 50 WDG | 2.5 b | 2.5 b | 3.0 b | 3.5 b | 3.2 b | 2.0 b | 2.0 b | 18.7 b | 82.0 |
| Solanum 500 SC | 2.7 b | 2.5 b | 3.0 b | 4.0 b | 3.0 b | 1.7 b | 2.5 b | 19.4 b | 81.4 |
| Dual gold 960 EC | 2.2 b | 2.0 b | 2.0 b | 2.7 b | 3.0 b | 1.2 b | 1.5 b | 14.6 b | 86.0 |
| Multiquat 200 SL | 00 b | 1.0 b | 1.2 b | 1.5 b | 1.0 b | 0.5 b | 0.5 b | 5.7 bc | 94.5 |
| Gramoxone 200 SL | 00 b | 1.2 b | 1.0 b | 1.5 b | 00 b | 1.0 b | 0.5 b | 5.2 bc | 95.0 |
| Weedy check | 15.5 a | 13.8 a | 13.5 a | 17.0 a | 21.0 a | 12.2 a | 11.0a | 104.0 a | --- |
| LSD | 4.2 | 3.6 | 4.8 | 6.2 | 6.8 | 2.9 | 3.2 | 10.0 | |

Means not sharing a letter differ significantly by LSD at 5% probability level

**Potato yield (kg ha$^{-1}$):** The yield parameter is the most important one in deciding the fate of the treatments applied on the crop for weed management strategy (Awan *et al*., 2010). It is evident from the results given in Table 3 that the treatments convincingly enhanced the yield of potato crop. The highest potato yield of 15910 kg ha$^{-1}$ with 36 percent increase over check was recorded in plots treated with Gramoxone 200SL + Dual gold 960EC followed by herbicide Gramoxone 200SL used alone having a yield of 15288 kg ha$^{-1}$ (33.53% increase over check) and Multiquat yielding 15022 kg ha$^{-1}$ with 32.35% increase over check. The lowest potato tuber yield obtained in the weedy check was 10162 kg ha$^{-1}$. The tuber yields recorded in the other herbicides were statistically at par with each other. The increase in tuber yield might be due to the effective weed control in herbicides application treatment as weeds are the major hindrance in reduction of potato tuber yield. The findings are in agreement with the results of Chirita (1995) who investigated 87% weed control and 14% yield increase with Sencor+Frontier 900 compared to weedy check, whereas Guttieri & Eberlein (1997) have reported yield increase with application of rimsulfuron+ metribuzin (Sencor). Similarly, Tyla & Tamosiunas (1996) and Ackley *et al*., (1996) reported yield increase in potato due to use of Sencor. Yaduraju *et al*., (1993) also obtained a variable yield of potato by using different herbicides.

**Table 3. Tuber yield (kg ha$^{-1}$) as affected by various herbicides application in potato crop.**

| Treatments | Tuber yield (kg ha$^{-1}$) | Yield increase over weedy check (kg ha$^{-1}$) | Percent increase in grain yield |
|---|---|---|---|
| Metribuzin 70 WP | 13160 bc | 2998 | 22.78 |
| Gramoxone 200 SL+Dual gold 960 EC | 15910 a | 5748 | 36.13 |
| Sencor 70WP | 13056 bc | 2894 | 22.17 |
| Torrent 50 WDG | 13895 b | 3733 | 26.87 |
| Solanum 500 SC | 13460 bc | 3298 | 24.50 |
| Dual gold 960 EC | 14132 b | 3970 | 28.09 |
| Multiquat 200 SL | 15022 a | 4860 | 32.35 |
| Gramoxone 200 SL | 15288 a | 5126 | 33.53 |
| Weedy check | 10162 d | --- | --- |
| LSD | 875 | | |

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