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EFFECT OF DIFFERENT HERBICIDES ON CONTROLLING WEEDS AND THEIR EFFECT ON YIELD AND YIELD COMPONENTS OF EDIBLE PEA (*Pisum sativum* L.)

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ABSTRACT

To study the efficacy of different herbicides on weeds and their effect on yield and yield components of edible pea (Pisum sativum L.), an experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during 2001-2002 using RCBD, having five replications. The experiment comprised of 8 herbicides, hand weeding and a weedy check. The herbicides included pre-emergence herbicides trifluralin @ 0.12 kg PPI, S-metolachlor @ 1.44 kg, pendimcthalin @ 0.99 kg and metribuzin @ 0.35 kg ai ha^{-1} and the post emergence herbicides oxadiazon @ 0.36 kg, propaquizafop @ .1.5 kg, isoproturon @ 0.63 kg and metribuzin @ 0.35 kg ai ha^{-1}. Variety Climax of pea in plot size 5x1.6 m^2 was planted during the last week of October, 2001. The data were recorded on percent germination, weed density (m^{-2}), phytotoxic effect on crop, plant height at maturity (cm), days to 50% pod formation, No. of pods plant^{-1}, pod length (cm), number of seeds pod^{-1}, 100 seed weight (g), shelling percentage and pod yield kg ha^{-1}. Herbicides metribuzin and S-metolachlor had 50%, while oxadiazon and trifluralin had 75% phytotoxic effect as determined by chlororsis on pea plants. The phytotoxicity, however disappeared in later growth stages in all the herbicides. All the parameters except number of pods plant^{-1} and number of seeds pod^{-1} were significantly affected by different herbicidal treatments. Minimum weeds m^{-2} (30.60) and the weed biomass g m^{-2} (96) were recorded in hand weeded plots followed by 76.80 weeds m^{-2} and 308 g m^{-2} weed biomass in post emergently treated metribuzin plots. Percent germination was adversely affected by pre emergence herbicides like trifluralin (90.53) and pendimethalin (95.53%). Post emergently applied oxadiazon and metribuzin treated plots availed maximum days to 50% pod formation due to their severe phytotoxic effect on pea plants. Pod length (9.612), No. of seeds pod^{-1} (6.14) and pod yield (4673 kg ha^{-1}) were the maximum in hand weeded plots, followed by post emergently metribuzin treated plots. Moreover, the maximum (43.85 g), 100 seed weight and shelling percentage (41.56) were also recorded in post emergently metribuzin treated plots. It is therefore suggested that the hand weeding may be supplemented with metribuzin as post emergence for effective weed management in edible pea.

INTRODUCTION

Edible pea (*Pisum sativum* L.) belongs to the family Leguminoseae and is an annual self pollinated, herbaceous plant which is a member of the diverse group of cultivated legumes or pulses. Cooked green peas are a rich source of proteins. One pound of green peas has 13.7 g protein, 8 g fat, 36.1 g carbohydrates, 45 mg calcium, 29 mg phosphorus and 54 mg ascorbic acid (Khan and Shakoor 1991). Pea is grown as vegetable crop, the world over. In Pakistan, total area under pea crop during 1999-2000 was 140 thousand hectares and production was 82 thousand tons with an average yield of 587 kg per hectare. During the same year total area under peas in NWFP was

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0.22 thousand hectares and production was 0.14 thousand tons with an average yield of 636 kg per hectare (Anonymous, 2000).

Non availability of promising varieties, poor production package and lack of sensitive market are the major bottlenecks in the increasing production of peas. But, the main hurdle in the way of increasing per hectare pea production is the weed competition. Weeds share soil fertility, moisture, solar radiation and space needed for crop plants and hence result in yield reduction. Weeds also deteriorate the quality of farm produce and hence reducing the market value. Season long crop-weed competition reduce the green pod yield by 44.6-55.6% (Dimitrova, 1998; Parakash *et al.* 2000). Townley and Wright (1994) reported that good weed control is critical to attaining high pea crop yield. Chemical control of weed has emerged as economical, efficient and quicker in action. Therefore, farmers all over the world have switched over to chemical method of weed control in their agronomic, horticultural and vegetable crops. Gurcharan et al. (1994) reported that all weed control treatments including hand weeding resulted in 79.6-85.1% control of weeds. Anxszka et al. (1998) reported that mixture of herbicides propisochlor @ 2.16 and prometryne @ 1.80 kg/ha were effective in achieving 99.5-100% reduction in weed biomass. In view of the importance of weed infestation in realizing the potential yields of pea crop, not only to cope with the domestic demand but also to produce an export surplus, an experiment was designed to investigate the efficacy of different herbicides in controlling weeds and quantify their consequent effects on various parameters of pea crop including yield and yield components.

MATERIALS AND METHODS

The present experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during rabi season 2001-2002. The lay out of experiment was in randomized complete block (RCB) design with 5 replications. There were 10 treatments (Table-1) in the trial. The plot size was kept at 5 x 1.6 m^2. All the recommended cultural practices were applied uniformly to all the treatments.

Table-1. Detail of treatments applied to the experiment.

Trade name	Common name	Time of application	Rate kg a.i.ha^{-1}	Commercial Product kg ha^{-1}
Treflon 4 EC	trifluralin	Pre-emergence	0.12	3
Dual Gold 960 EC	S-metolachlor	Pre-emergence	1.44	1.5
Stomp 330 EC	pendimethalin	Pre-emergence	0.99	3
Sencor 70 WP	metribuzin	Pre-emergence	0.35	0.5
Ronstar 12L	oxadiazon	Post-emergence	0.36	3
Agil 100EC	propaquizafop	Post-emergence	1.5	1.5
isoproturon 50 WP	isoproturon	Post-emergence	0.63	1.26
Sencor 70 WP	metribuzin	Post-emergence	0.35	0.5
Hand weeding	----------	-----	-----	
Weedy check	----------	-----		

The herbicides were applied with a knapsack sprayer. To apply the herbicides successfully, all the precautionary measures were kept into focus so as to avoid any hazard by the misuse of the herbicides.

During the course of studies, the data were recorded on weed density (m^{-2}) 30 days after herbicides application, weed biomass (g m^{-2}) at the final picking of pea, percent germination of pea, phytotoxic effect on plants visually observed after the herbicides application, plant height at maturity (cm), days to 50% pod formation, number of pods $plant^{-1}$, pod length (cm), number of seeds pod^{-1}, 100 seed weight (g), shelling percentage and pod yield (kg ha^{-1}). The data for the

individual trait was subjected to the analysis of variance technique and the significant means were subsequently separated by the LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weed density (m^{-2})

Statistical analysis of the data regarding density of weeds m^{-2} after application of herbicides revealed that herbicide treatments had significant effect on weed density. The data showed that highest weed population m^{-2} (284.6) was observed in weedy check plots while minimum population (30.60) of weeds m^{-2} was observed in hand weeded plots followed by post emergently metribuzin treated plots with 76.80 weeds m^{-2} (Table-2). There was a higher infestation of broad leaf weeds as compared to the grassy weeds. The predominant weeds in the experiment were *Anagallis arvensis* L., *Chenopodium album* L. *C. murale*, *Coronopus didynus* L., *Vicia sativa* L. *Fumaria indica* L. and *Cyprus rotundus* L. Our findings reveal that hand weeding and post emergently applied metribuzin gave maximum control of weeds infesting pea crop. These were followed by propaquizafop and oxadiazon in controlling weeds as compared to the other herbicides. Maximum weeds were observed in weedy check plots. These results are in conformity with those reported by Gurcharan et al (1994) who stated that all weed control treatments including hand weeding resulted in 79.6-85.1% control of weeds in their studies.

Weed biomass (g m^{-2})

The statistical analysis of the data revealed that different herbicide treatments had significantly affected weed biomass (g m^{-2}). The maximum weed biomass (1271 g m^{-2}) was recorded in weedy check plots followed by propaquizafop (1078 g m^{-2}) and isoproturon (861.6 g m^{-2}). While, the lowest weed biomass of only 96 g m^{-2} was obtained from hand weeded plots followed by metribuzin post emergently treated plots with 380 g m^{-2} and pendimethalin with 400 g m^{-2} (Table-2). The higher weed biomass in weedy check and propaquizafop treated plots is that earlier was the unweeded check and latter did not control weeds, because it is grass specific herbicide and there was a preponderance of broadleaf weeds in the instant experiment. The metribuzin gave good control of weeds and hence reduced the weed biomass. The results are in conformity with the inferences of Anxszka et al. (1998).

Percent germination of pea

The statistical analysis of the data showed that the herbicidal application had significant effect on germination of seeds. The data in Table-2 exhibit the highest percent germination (99.47) as recorded in post emergently metribuzin treated plots which is statistically at par with weedy check (98.42) and hand weeding plots (97.89), while the lowest germination (90.53) was observed in plots treated with trifluralin followed by pendimethalin treated pre emergently (95.26). The lower germination in trifluralin and pendimethalin treated plots may be attributed to their adverse effect on pea germination. Similar results were also reported by Singh and Wright (1999) who stated that all pre mergence herbicides had decreased germination of pea in their studies.

Phytotoxic effect on crop

The data on phytotoxic effect of herbicides, mainly based on visual rating of each plot for any phytotoxicity caused by the herbicides exhibited the maximum (75%) phytotoxicity in oxadiazon and trifluralin treated plots while, 50% phytotoxicity was caused by application of pendimethalin, metribuzin and S-metolachlor as applied in pre-emergence. The rest of treatments e.g. propaquizafop, Isoprotoron and metibuzin pre-emergence had either negligible or zero phytotoxicity. The symptoms of phytotoxicity disappeared in the concerned treatments in the advanced growth stages of the crop. Analogous findings have been communicated by Jenson et al (1996), who noticed phytotoxicity to pea crop by all the herbicidal treatments.

Plant height at maturity (cm)

The statistical analysis of the data revealed that different herbicidal treatments had affected the plant height significantly. Maximum plant height was recorded in weedy check plots (100.00 cm) which however, was statistically similar to the plant height of 96.80 cm as observed in hand

weeding plots. The minimum plant height (77.4 cm) was recorded in plots treated with oxadiazon and trifluralin with 78.6 cm plant height (Table-2), which however was only significantly different in height from the top scoring treatments, S-metolachlor and isoproturon treated plants. The maximum plant height in weedy check may be because of competition of pea plants with weeds for sunlight, which produced leggy, taller and weaker growth, while the taller plants in hand weeding plots were probably as a result of ample space, nutrients, light and moisture, without exposure to a herbicidal stress. The results are in line with that of Singh and Wright (1999) who stated that the decreased growth of herbicide treated plants was due to direct effects of herbicides on pea.

Days to 50% pod formation

Different herbicidal treatments had significant ($P<0.001$) effect on days to 50% pod formation. The maximum (101.2) days to 50% pod formation were recorded in plots where oxadiazon was post-emergently applied. It was however, statistically at par with post-emergently treated metribuzin plots with 98.40 days to 50% pod formation. The minimum (91.60) days to 50% pod formation was deciphered in pre emergently metribuzin and isoproturon (91.60) treated plots, but however, these were statistically at par with hand weeding (92.00), propaquizafop (92.00) , S-metolachlor (92.20) and weedy check (93.6) [Table-2]. The maximum days to 50% pod formation in oxadiazon and metribuzin post emergence treatment could be a result of phytotoxic effect of these herbicides on pea. Similar results were also reported by Gealy et al (1995) who stated that sulfonylurea and phenoxy herbicides due to their phytotoxicity delayed flowering and maturity of pea plants.

Number of pods plant^{-1}

The herbicidal treatments had non-significant effect on number of pods plant^{-1} exhibiting that the trait under reference is strictly under the genetic control and not being influenced by the environment. However, means in Table-2 show that plots where hand weeding was practiced had the highest number of pods plant^{-1} (32.92), while weedy check plots had the least number of pods plant^{-1} (18.58). The results are in agreement with those reported by Miller and Libbex (1999) who observed that herbicide treatments for weed control did not affect pea plant density and number of pods plant^{-1}.

Pod length (cm)

Different herbicidal treatments had significantly affected the pod length. The data recorded for pod length show that maximum pod length (9.612 cm) was measured in hand weeded plots followed by post the emergently treated metribuzin plots (9.284 cm), while the weedy check plots produced lowest pod length of only 8.44 cm. It is however, statistically at par with propaquizafop treated plots with 8.67 cm, oxadiazon 8.636 cm and trifluralin 8.670 cm. (Table-2). The maximum pod length in hand weeded plots could be attributed to the fact that weeds were completely controlled throughout the cropping season and pea plant did not face the competition with weeds. These results are in conformity with the findings of Prakash et al. (2000) who stated that the highest pod length was recorded under the repeated hand weeding treatments.

Number of seeds pod^{-1}

The herbicides had non-significant effect on the number of seeds pod^{-1}. However, the data pertaining to number of seeds pod^{-1} show that maximum number of seeds pod^{-1} (6.14) were recorded in plots where hand weeding was practiced, while minimum number of seeds pod^{-1} (4.518) were recoded in plots where oxadiazon was applied for weed control (Table-2).

These results are contrary to the findings of Prakash et al. (2000) who stated that maximum number of seeds pod^{-1} were recorded in plots where weeds were controlled. The difference in inferences could be assigned to the different density ad frequency of weeds and genotypic response of pea in the two studies.

100 seed weight (g)

Statistical analysis of the data revealed that herbicides had significant effect on 100 seed weight (g). The maximum (43.85 g) 100 seed weight was obtained from post emergently applied metribuzin plots. It was statistically at par with hand weeding (42.75 g) and metribuzin pre

emergently applied (40.47 g) treatments. The lowest (32.30 g) 100 seed weight was recorded in weedy check plots followed by isoproturon treated plots with 33.73 g 100 seed weight (Table-2). The lowest 100 seed weight in weedy check plots is the outcome of competition of crop plants with weeds throughout the growing season for nutrients, space and light. Our results are in agreement with those reported by Dimitrova (1998) who stated that weeds competition lowered pea grain yields by 45% while herbicide treatments increased pea grain yields by 39-44%.

Shelling percentage

The shelling percentage is a good index of the highly desired economic yield i.e pea seeds. Higher the percentage, more is the contribution towards the economic yield. Different herbicidal treatments had significant effect on shelling percentage. Post emergently applied metribuzin plots gave maximum shelling percentage (41.56). However, it was statistically comparable with hand weeding (40.92) and S-metolachlor (38.76) treated plots. The minimum (30.65) shelling percentage was recorded in weedy check plots followed by isoproturon (33.44) [Table-2]. The maximum shelling percentage in metribuzin and hand weeding plots can be attributed to the excellent weed control in these treatments, which influenced the higher parttioning of the photosynthate into the seeds. The results are in corroboration with the work of Prakash et al. (2000) who stated that maximum shelling percentage was recorded in plots under repeated weeding treatments.

Pod yield (kg ha^{-1})

The statistical analysis of the data indicated that different herbicidal treatments had significant effect on the pod yield (kg ha^{-1}). The highest pod yield (4673.0 kg ha^{-1}) was observed in hand weeding plots followed by metribuzin post emergently treated plots (3495.0 kg ha^{-1}). The lowest pod yield (2399.0 kg ha^{-1}) was recorded in weedy check plots (Table-2). The low pod yield in weedy check plots might be the result of weed competition with pea plants. These result are in conformity with Prakash et al (2000). The maximum yield of hand weeding and post emergently metribuzin treated plots is the consequence of better weed control which diverted the utilization of resources like nutrients, solar radiation water and space to the pea crop. These results are in a great analogy with the findings of Townley and Wright (1994) who stated that good weed control is critical to attaining high pea crop yield.

Table-2. Effect of different herbicides on weed control and some quantitative parameters of edible pea *(Pisum sativum)*

S No	Treatments	Number of weeds m^{-2}	Weed biomass (g m^{-2})	Percent germination	Days to 50% pod formation	Number of pod plant	Pod length (cm)	Number of seeds pod	100 seed weight (g)	Shelling percentage	Plant height at maturity (cm)	Pod yield (kg ha^{-1})
1	Trifluralin	125.4 D	432.0 D	90.53 D	96.80 BC	21.36	8.670 C	5.174	36.89 CD	36.91 BC	78.60 CD	2955.0 BC
2	Metribuzin PSE	76.80 E	38.0 DE	99.47 A	98.40 AB	26.08	9.284 AB	6.060	43.85 A	41.50 A	83.00 BCD	3495.0 B
3	S-metolachlor	201.0 B	817.6 C	95.26 C	92.20 D	25.32	8.972 B	5.470	39.08 B	38.76 AB	85.80 BC	3335.0 BC
4	Pendimethalin	156.0 CD	400.0 D	95.26 C	92.80 D	21.74	8.780 BC	5.242	37.89 CD	34.33 D	79.00 CD	3278.0 BC
5	Oxadiazon	138.0 D	512.8 D	97.89 AB	101.2 A	21.24	8.636 C	4.518	38.11 C	35.85 CD	77.40 D	2900.0 BC
6	Isoproturon	177.0 BC	861.6 BC	97.89 AB	91.60 D	21.26	8.810 BC	5.396	33.73 E	33.44 DE	88.40 B	2525.0 BC
7	Propaquizafop	200.4 B	1078.0 BC	97.36 AB	92.00 D	19.72	8.488 C	4.532	34.52 D	37.03 B	81.40 BCD	2468.0 C
	Metribuzin PRE*	145.2 CD	480.0 D	95.78 B	91.60 D	25.66	8.938 BC	5.164	40.47 AB	36.45 C	84.00 BCD	2918.0 BC
9	Hand weeding	30.60 F	96.00 E	97.89 AB	92.00 D	32.92	9.612 A	6.148	42.75 AB	40.92 AB	96.80 A	4673.0 A
10	Weedy check	264.6 A	1271.0 A	98.47 AB	93.60 CD	18.58	8.448 C	5.088	32.30 E	30.65 E	100.0 A	2399 C
	$LSD_{0.05}$	36.31	252.1	2.75	3.29	NS	0.58	NS	4.60	4.34	8.11	987.0

[1] Means sharing a letter in common in the respective category do not differ significantly by LSD test at 5% probability level.
[2] PSE = post-emergence

* PRE = pre-emergence.

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