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Original Research Article

INFLUENCE OF VARIOUS WEED MANAGEMENT PRACTICES ON WEEDS AND YIELD COMPONENTS OF PEA (*PISUM SATIVUM* L.)

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Abstract *A field experiment was conducted throughout the winter cropping season of the year 2018, at the New Developmental Research Farm (NDRF), the University of Agriculture-Peshawar, to assess the efficiency of techniques for weed control on weed suppression, and yield components of edible pea. The research was designed, using a Randomized Complete Block Design, with 13 treatments, which were repeated 3 times. The applied treatments comprised; Mulches (Eucalyptus leaves, weed biomass, and poplar leaves), herbicides (S-metolachlor, Pendimethalin, Haloxyfop-p-methyl, and Quizalofop-p-ethyl), and hand-weeded plots (hand weeding at 20 DAS, hand weeding at 40 DAS, hand weeding at 60 DAS, and two times hand weeding at 30 and 60 DAS), weed-free, and weedy check(untreated). Parameters documented included; weed density (m-²), fresh biomass (kg ha-¹), seeds pod-1, hundred seed weight (g), seed yield (kg ha-¹), and CBR. Based on our outcomes, the weedy check, had the highest weed density (40.1 m-²), and fresh biomass (441.67 kg ha-¹), whereas the weed-free treatment had the lowest values for both parameters. Likewise, in terms of agronomic parameters, the weed-free treatment produced the highest seeds (8.10 pod-1), hundred seed weight (53.33 g), and seed yield (4352 kg ha-¹). While, the weedy check treatment, exhibited the lowest values for these parameters. The use of Pendimethalin produced the highest cost-benefit ratio (CBR), while hand weeding and mulching produced the lowest CBR. These findings suggest that of various weed control methods, twice hand weeding, and the application of Pendimethalin, and S-metolachlor are effective for controlling weeds, and enhancing yield-related traits of pea.*

Keywords: *Edible pea; hand weeding; herbicides; mulches; seed yield; weeds*

Introduction

Pea (*Pisum sativum* L.), is one of the most prominent winter vegetable crops, which belongs to the Fabaceae family. It is an herbaceous, self-pollinating, annual plant, that flourishes in cold, moist climatic conditions. Temperatures between 10°C and 30°C are ideal for seed development. The ideal pH range for pea production is 5.9 to 6.5, and the plants need loamy soil, that drains certainly, and has a lot of calcium (Khalil and Jan, 2002). Pea is an essential legume grown on 7.06 million hectares around the globe, producing 13 MMT. The USA, France, China, India, and Egypt are the world's largest producers of green peas. Peas are used in a variety of ways, including food preparation, soups, and other items. They include high levels of inexpensive protein, different vitamins, carbohydrates, antioxidants, and minerals. Dried pea grains have 24% protein, which is much higher than wheat grains 9% protein content (Urbano et al., 2003). According to the FAO (2011), peas are the 3rd utmost vital pulse crop in Pakistan. The whole country produces almost 114,925 tonnes of grains annually, from the cultivation of peas on approximately 17,406 hectares. Peas are produced on 1,942 hectares in Khyber Pakhtunkhwa, yielding 13,418 tonnes (MNFSR, 2015). Pakistan's pea production is far lower than, that of agriculturally advanced countries. The adoption of low-yielding

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cultivars, traditional agricultural methods, and the contrasting effects of climatic conditions are some of the causes, that contribute to this poor yield. Weed opposition, however, is the main reason. According to Jilani et al. (2016), who stated that weeds are undesirable plants, that strive with crops for vital resources like nutrients, sunlight, and moisture, which ultimately results in lower, and lower-quality yields. According to reports, unchecked weed improvement can result in yield losses of up to 77.2% in peas (Brijbhooshan et al., 2017). Weeds in Pakistan cause 39% to 89% of pea yield losses, which parallels a financial loss of Rs. 9.5-21.7 billion (Agriculture Statistics of Pakistan, 2012). Pea weed opposition is most important between (40 and 60) days post-sowing. According to Bond and Grundy (2000), the objective of weed management is to increase the crop capability to strive with weeds, not to eradicate them. There are many different chemical, and non-chemical weed management methods existing to growers, such as cultural, mechanical, biological, and chemical control techniques. When it comes to controlling weeds in peas, cultural weed control is the most practical method. Mulching, inter-cultivation, and cover crops are just a few of the cultural strategies, that have been effectively used for vegetable crops (Lemerle and Murphy, 2000; Abbas et al., 2024ab; Irfan et al., 2024). Field sites have shown that mulching is a more economical, and labor-efficient technique than hand weeding. According to Sinkevicience et al. (2009), mulches stop weed seeds from germinating by covering the soil's surface and upsetting the ideal growth circumstances. Furthermore, mulching protects soil moisture, and inhibits weed growth in between crops, making it a safe, and environmentally valuable weed control method. The density of weeds can be successfully reduced by mechanical weed control methods, such as hand weeding, and hand hoeing (Marshal, 1992). Studies have indicated that higher pods yield are achieved from plots, that are kept weed-free during the growth season by manual weeding (Junaid and Gokce, 2024; Rehamn et al., 2024; Singh and Angiras, 2004; Tewari et al., 2003). According to Misra and Bhan (1997), herbicide sprays have been found to provide lower yields, than hand weeding. Chemical weed control is commonly selected, because it is rapid, effective, and practically evaluated compared to mechanical, and cultural control methods. According to Patel et al. (2006), it is essential to contemporary crop production systems and enhances conventional methods. Herbicide use is essential for effective weed management in situations of substantial weed infestation. Herbicide use done correctly continues to be the most successful way to control weeds in the face of such problems (Rahman et al., 2012; Sami et al., 2023; Fayad et al., 1998). The current research aims to assess the efficiency of several weed control techniques for increasing field pea yield.

Materials and methods

To investigate how different weed control techniques influenced peas, a field experiment was carried out at the University of Agriculture, Peshawar, a new developmental research farm, during the 2018 winter growing season. The thirteen treatments in the research study were set up using a Randomized Complete Block Design (RCBD), and each was repeated three times. There were three ridges in each plot, each measuring three meters in length, with a 60-cm space between rows, and a 15-cm gap between plants. The treatments include; where eucalyptus leaves, weed biomass, and poplar leaves, which were used as mulches at 20 DAS. Chemical treatments comprised; S-metolachlor at the rate of 1 L ha^{-1} at 1 DAS, Pendimethalin applied at 2.5 L ha^{-1} at 1 DAS, Haloxyfop-p-methyl applied at 0.9 L ha^{-1} at 20 DAS, and Quizalofop-p-ethyl applied at 75 ml ha^{-1} at 20 DAS. Manual weed control included; hand weeding at 20 DAS, hand weeding at 40 DAS, hand weeding at 60 DAS, and involving twice hand weeding at 30 and 60 DAS. Moreover, weed-free, and weedy check (untreated) were also included. Each treatment was employed on a plot size of 3 m × 2 m. In November 2018, the "PF 400" hybrid variety, seeds were manually planted. To set up a fine seedbed, the field was prudently preferred, and prepared by using a cultivator to plough twice and then planking. In subsequent field preparation, the pea variety was planted in the experimental field on ridges that had been built.

Statistical Analysis

The collected data on numerous parameters were investigated separately using the ANOVA procedure through the Statistix 8.1 software (Steel, 1980).

Results and discussions

Weed density (m^{-2})

The analysis of variance indicated that numerous weed management approaches had extensive control over the weed population in field pea. Table 1, indicated that the utmost weed density (40.10 m^2) was noted in the control treatment, and the lowest density (1.06 m^2) was documented in the weed-free treatment. The plot with twice hand-weeding (30 and 60 DAS), had the lowest weed density (7.26 m^2), indicating a significant difference from the other hand-weeded plots. Brijbhooshan et al. (2017), stated that manual weeding was more successful than other control techniques, in terms of weed density, and biomass reduction. In contrast to the other herbicidal treatments, Pendimethalin had the least weed density (8.66 m^2) among the herbicidal treatments, that was followed by eucalyptus leaves mulch (15.66 m^2), and S-metolachlor (10.60 m^2), both of which were substantially different from one another. As supported by their greater cost-benefit ratio, the

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usage of herbicides like S-metolachlor, and Pendimethalin has proven to be more effective than other control methods, for controlling weeds. Particularly successful in lowering weed density were the herbicides Pendimethalin, and S-metolachlor (Montanya et al., 2014). Current results exhibited that a variety of weed control techniques intensely declined weed density. Our consequences coincide with those of Waseem et al. (2018), who described that field pea weeds were effectively suppressed by weed management techniques, that eradicated both grassy and broadleaf weeds.

Fresh weed biomass (kg ha^{-1})

Table 1 revealed that the weedy check (441.67 kg ha^{-1}), and hand-weeding 40 DAS (425 kg ha^{-1}), plots had substantially higher fresh weed biomass, compared to all other plots. The weed-free plot had the lowest fresh biomass (59.33 kg ha^{-1}). The Pendimethalin application had considerably lower fresh biomass (238 kg ha^{-1}), paralleled to the S-metolachlor (258.67 kg ha^{-1}) treatment. Pendimethalin and S-metolachlor application had a strong phytotoxic effect on weeds, which resulted in reduced fresh weed biomass. Two-hand weeding resulted in better weed control and weed biomass reduction. Conversely, manual weeding is not the best weed management strategy, when linked to chemical application, because it is labor-intensive, time-consuming, and costly. As a result, herbicides are a better choice for controlling weeds. Our conclusions are reliable with those of Sajid et al. (2012), who stated that using herbicides, resulted in the lowest fresh weed biomass.

No. of seeds pod^{-1}

Various weed-controlling techniques, had an important influence on the seed pods^{-1}. Table 1 demonstrates that the hand weeding twice at 30 and 60 DAS (8.40 pod^{-1}), and the weed-free check (8.10 pod^{-1}) treatment, had the highest seed numbers, which was followed by chemically treated plots of Pendimethalin (7.93 pod^{-1}), and S-metolachlor (7.73 pod^{-1}) both are statistically differed from one another. Hand weeding at 40 and 60 DAS produced 6.13 seeds per pod, while the weedy check and hand weeding at 20 DAS produced the fewest seeds (5.26 and 5.46 pod^{-1}). The successful weed control techniques in the chemically treated, and hand-weeded plots, ultimately increased seed output, as seen by the higher seeds pod^{-1}. As demonstrated by the higher seeds pod^{-1}, it can be concluded from the aforementioned data, that weed population reduction directly boosts field pea productivity. This supports the conclusions of Chaudhary et al. (2011), who suggested that increasing the number of seeds can be achieved by lowering weed opposition.

100 seeds weight (g)

Statistical analysis presented in Table 1, revealed that the utmost 100-seed weight (53.33 g) was recorded in the weed-free check treatment, followed by the chemically treated plots Pendimethalin (50.66 g), and S-metolachlor (49.66 g), both of which were significantly alike. The control (untreated) treatment resulted in the least 100-seed weight (42.33 g), which was considerably dissimilar from all other control treatments. Among various mulches, a mulch of eucalyptus leaves contributed to a 100-seed weight of (47.66 g). Our outcomes suggested that, when likened to the weedy check, chemical control treatment, considerably improved the hundred seeds' weight, among the different weed control techniques. The most efficient hand-weeding method for reducing weed density, and enhancing seed output. This consequence is in line with Sajid et al. (2012), who correspondingly found that various weed management techniques considerably, improved the weight of hundred seeds.

Seed yield (kgha^{-1})

Table 1 demonstrated that the highest seed yields were acquired from the weed-free check (4352 kg ha^{-1}), and the hand-weeded plot at 30 and 60 DAS (251 kg ha^{-1}), which were significantly parallel. These were trailed by the application of Pendimethalin (3919 kg ha^{-1}), and S-metolachlor (1373 kg ha^{-1}) respectively, both were significantly different from all others. While, the lowest seed yield (1373 kg ha^{-1}), was observed in the control treatment, which significantly differed from all other treatments. Additionally, mulching of eucalyptus, and poplar leaves, caused seed yields of 3294 and 3282 kg ha^{-1}, correspondingly. Among various weed control strategies, twice-hand weeding, extensively reduced weed population, and improved pea production, followed by the use of herbicides like Pendimethalin, and S-metolachlor. Our outcomes suggested that proper herbicide management is critical for enhancing the grain production of edible pea. These consequences are consistent with Chaudhary et al. (2011), who found that manual weeding caused greater seed yields, than the control treatment.

Cost-benefit ratio (CBR)

The Pendimethalin-treated plot had the highest cost-benefit ratio (6.7), followed by the application of S-metolachlor (5.6) treatment shown in Table 1. In comparison, the control treatment (weedy check) had the lowest cost-benefit ratio (1.9). Chemical treatments have a higher CBR because they contain less labor, than other methods of weed control. Increased confidence in physical labor, on the other hand, raises the entire cost of crop production. As a result, the usage of herbicides, improved pea growers' net returns. Muhammad et al. (2011), reported that chemically treated plots had a greater cost-benefit ratio, which is in line with our findings. Compared to the usage of chemicals, labor costs in Pakistan are relatively high, and these costs can fluctuate by location, which ultimately affects net

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income. In light of our outcomes, we recommended that synthetic herbicides are a more economical way for small, and vast landholding farmers to increase crop yield production.

Table-1 Weed density, fresh weed biomass, no. of seeds,100 seeds weight, seed yield and cost-benefit ratio as influenced by various weed control methods in pea

Treatments	Weed density (m^{-2})	Fresh weed biomass ($kgha^{-1}$)	No. of seeds $pods^{-1}$	100 seeds weight (g)	Seed yield ($kgha^{-1}$)	Cost-benefit ratio
Eucalyptus leaves as mulch	15.66 f	302.33 h	7.53 e	47.66 ef	3294 cd	1:4.3
Weed biomass as mulch	20.56 d	371.00 e	6.83 h	44.33 hi	3020 de	1:3.4
Poplar leaves as mulch	17.66 e	341.33 f	7.36 f	47.00efg	3282cd	1:3.6
S-metolachlor	10.60 g	258.67 i	7.73 d	49.66 cd	3557 c	1:5.6
Pendimethalin	08.66 h	238.00 j	7.93 c	50.66 bc	3919 b	1:6.7
Haloxyfop-p-methyl	22.00 c	381.67 d	7.40 ef	48.33 de	1903 h	1:5.1
Quizalofop-p-ethyl	19.86 d	404.33 c	7.03 g	46.33 fg	1927 h	1:4.2
Hand weeding (20DAS)	26.10 b	412.67 c	5.46 j	42.66 j	2500 fg	1:2.8
Hand weeding (40DAS)	17.36 e	425.00 b	6.00 i	43.00 ij	2767 ef	1:2.8
Hand weeding (60DAS)	15.06 f	315.67 g	6.13 i	45.66 gh	2254 g	1:3.0
Hand weeding twice (30 and 60 DAS)	07.26 i	222.00 k	8.10 b	52.00 ab	4251 a	1:3.4
Weed-free	01.06 j	59.33 l	8.40 a	53.33 a	4352 a	1:4.6
Weedy check (untreated)	40.10 a	441.67 a	5.26 k	42.33 j	1373 i	1:1.9
LSD (0.05%)	00.80	9.09	0.14	1.63	300	

Conclusion

The combination of mechanical, chemical, and cultural weed control methods had a substantial impact on pea yield and weed infestation, according to our research.

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Authors' Contribution

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Conflict of interest

There is no conflict of interest among the authors of the manuscript.