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IMPACT OF VARIOUS WEED MANAGEMENT APPROACHES ON THE YIELD OF CHICKPEA *CICER ARIETINUM* L. CROP

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Abstract

A 2-year field trial was carried out at the Agricultural Research Station of Ahmad Wala, district Karak of Khyber Pakhtunkhwa province of Pakistan during the chickpea growing seasons of 2014 and 2015 in order to investigate numerous weed control practices on the yield and yield components of chickpea crop. Nine treatments were used in the experiment viz; weedy check, hand weeding, the herbicides Stomp 330 EC, Puma Super 75 EW, Dual Gold 960 EC, Topik 15 WP, Isoproturon 500 EW and water extracts of Parthenium and Eucalyptus. The year effect was found significant after combined analysis of the data over the years. Similarly, all the treatments significantly affected weed density m^{-2}, number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, and the seed yield of chickpea (kg ha^{-1}) during both the years. With the application of Isoproturon 500 EW, a significantly lower weed density was recorded as compared to control plots in 2014 as well as in 2015. In contrary, a significantly highest chickpea seed yield was obtained in the plots of Isoproturon 500 EW in the two years study while the second best was the application of *Eucalyptus* extract that produced the second highest seed yield of chickpea in both the trials. In case of water extract, the Eucalyptus extract was superior to Parthenium extract in terms of weed control. It was concluded that Isoproturon 500 EW can be the desirable method for obtaining the optimum weed control and desirable seed yield of chickpea crop in the agro-ecological conditions of Karak, Pakistan.

Key words: Herbicides, Chickpea, Weed extract, Weed control.

Introduction

Cicer arietinum L. (chickpea) nowadays is the 3rd major crop among all the pulse crops in the world, grown mostly in the Mediterranean regions and West Asia (Poltronieri *et al.*, 2000). It is a very good source of dietary protein especially for the vegetarians' worldwide (Viveros *et al*., 2001). It plays an important role in the soil fertility because of its capability to fix atmospheric N_2. The cultivars of chickpea are of two types i.e. Desi and Kabuli. The Desi cultivars seeds are smaller in size having dark brown to blackish color. On the other hand, Kabuli seeds are of larger sizes and have creamy colour with smoother seed coats (Singh *et al.*, 1991).

The chickpea crop has also achieved a great importance in Pakistan because of its use in various products. On national level, the area under chickpea crop cultivation was 1.0806 million ha during 2012-2013 with total production of 0.7405 million tons having an average yield of 685 kg ha^{-1}. The area under its cultivation, on provincial level, was 0.042 million ha achieving 0.020 million tons total production (Anon., 2014). There are a number of reasons due to which the mean yield of chickpea crop is quite lower all over Pakistan than the worldwide advanced chickpea producing countries; however, the most important and key reason is the weeds infestation in the crop fields. Weeds compete with the crop for sunlight reception, nutrients uptake, space capture, and moisture uptake which definitely lead to the lower yields of the crop in encounter (Iqbal *et al*., 2010; Khattak *et al*., 2015).

The weeds that are usually found in the crop of chickpea grown in the rainfed areas are *Lathyrus aphaca* L., *Fumaria indica* L., *Anagallis arvensis* L., *Medicago ploymorpha* L., *Cynodon dactylon* (L.) Pers., *Cyperus rotundus* L., *Carthamus oxyacantha* L. and *Convolvulus arvensis* L. etc. (Naghashzadeh & Beyranvand, 2015). The broad leaved weeds have more competitive ability against the chickpea crop plants due to the similarity in their growth habits and the severity of the competition escalates with the passage of time (Bhan & Kukula, 1987). Batish *et al*., (2007) is of the view that the weed interference existing in the agronomic crops inflicts greater yield losses in the agro-ecosystems worldwide. The use of mechanical methods e.g. hand weeding etc. are highly time consuming and laborious too; whereas the long term herbicides application might result herbicide-resistance in the associated weeds and also poses threat to human health and environmental integrity (Vyvyan, 2002). In the near past, huge efforts are made to assess the allelopathic effects of various weeds or crop plants for their capability in sustainably controlling the weeds (Singh *et al*., 2003c). The phyto herbicides obtained from the medicinal and toxic plants' residues may help minimize the synthetic herbicides large scale use by the farming community. This will therefore cause minimum environmental pollution and will result in health friendly agricultural production (Khanh *et al*., 2007; Singh *et al*., 2003a).

Therefore, in light of the economic and social importance of the chickpea crop and its yield losses due to weeds competition, this study was conducted to investigate the capability of the water extracts of the commonly available plants for their allelopathic effects on weeds and the herbicides for their weed control in chickpea crop. The main objectives were to assess the phytotoxic effect of water extracts of certain plants and of herbicides on chickpea crop production, to evaluate the efficacy of certain herbicides and water extracts of plants for weeds control in chickpea cop, and to compare the effects of the extracts and herbicides regarding weed control and chickpea crop yield.

Materials and Methods

A two-year field trial was undertaken at the Agricultural Research Station of Ahmad Wala situated in Karak district of Khyber Pakhtunkhwa province of Pakistan during the chickpea growing seasons of 2014 and 2015. The layout of the experiments was in RCB design keeping a total of four replications. Certified category seed of chickpea variety 'Karak 1' was cultivated using a hand hoe at a sowing rate of 70 kg ha^{-1}. Each plot had a size of four meter length, 1.5 m width, with plant-plant and row-row spacing of 10 and 30 cm, respectively. A distance of 30 cm was kept among the adjacent rows during the cultivation process. All other agronomic practices like cultivation method, irrigation, fertilizer application etc. were kept constant for all the applied treatments. The treatments consisted of Stomp 330 EC @ 2.47 L and Dual Gold 960 EC @ 2.0 L ha^{-1} which were sprayed as pre-emergence herbicides; Puma super @ 2.0 kg ha^{-1}, Topik 15 WP @ 0.20 kg and Isoproturon 500EW @ 125.0 g a.i. ha^{-1} were used as post-emergence herbicides; Eucalyptus and Parthenium extracts both were applied post emergence @ 125 g L^{-1}. The treatments also included a hand weeding and a control (the weedy check). The control plot was kept for comparison purpose. The water extracts were prepared by soaking the chaffed herbage of the Parthenium and Eucalyptus by soaking in distilled water for 24 hours. It was then filtered to collect the respective extracts.

The data was recorded on various parameters, including (1) weed density m^{-2}, (2) no. of pods plant^{-1}, (3) no. of branches plant^{-1}, (4) no. of seeds pod^{-1}, and (5) seed yield of chickpea (kg ha^{-1}). After 15 days of treatments application, weed density was recorded in all the treatments. Weeds were counted using a quadrat of size 33 cm x 33 cm thrown at three randomly selected sites in each treatment plot and subsequently the means were taken from the three observations and then the values were converted to per square meter. In each treatment, a total of five representative plants were selected randomly and then the no. of branches plant^{-1} was calculated, and then the means were computed. Similarly, by selecting five representative plants in each treatment, the no. of pods plant^{-1} was noted and then means were computed and recorded. Moreover, 20 pods were randomly collected from five tagged plants in each treatment, and their seeds were counted and the average was calculated. For seed yield, four middle rows of each treatment were harvested, then the seeds were separated from pods and were weighed. Finally, by using the following formula, the seed yield kg ha^{-1} was calculated.

$$\text{Chickpea seed yield } (\text{kg ha}^{-1}) = \frac{\text{Seed yield (kg) from the treatment plot}}{\text{Harvested area of the treatment plot}} \times 10000$$

Statistical analysis

The data were analyzed statistically with the help of the statistical software Statistix 8.1, according to the ANOVA of RCBD. The significant means were then separated by LSD test at $\alpha = 0.05$ (Steel & Torrie, 1984). The year effect was calculated by the combined analysis of the two year data for each parameter. As the year effect was significant, the data means for the years 2014 and 2015 has been represented separately in each table along with their LSD values for separate years.

Results and Discussion

Weed density m^{-2}: Table 1 showed that the effect of the herbicides and the applied extracts was significant on the weed density m^{-2} in both the experiments conducted in 2014 and 2015. However, the density in 2014 was higher than the mean weed density in 2015 (Table 1). The number of weeds m^{-2} was highest in control plots (268.3 and 102.57 weeds m^{-2}) in 2014 and 2015, respectively. The second highest weed density was in the plots sprayed with Puma super 75 EW (88 and 46 weeds m^{-2}, respectively in the two years. The weed density was lowest in the plots of Isoproturon 500 EW (6.0 and 10.9 weeds m^{-2}, respectively) followed by hand weeding treatment (12.3 and 12.83 weeds m^{-2}). The variation in the population of weeds in the various treatments was because of the herbicides effect on weed control as compared to weedy check. Previously, Singh & Singh (1998) and Ahmad *et al.*, (1990) had reported that Stomp 330 EC was the most effective herbicide for weeds control in chickpea, but it seems the effect mainly depends on the type of weed species and severity of the weed infestation. Moreover, the better results given by the herbicides are due to their higher selectivity and more toxicity as compared to the plant extracts because the plants water extracts are lacking the capability of more selectivity to control weeds efficiently but, they do have the capability to retard the growth of weeds due to which they lose their competition capabilities, and consequently the crop get more nutrients as compared to weeds. Similarly, Muhammad *et al*., (2011) regarded the pre emergence herbicide Stomp 330E @ 3.50 lit ha^{-1} as the best weed control treatment that managed weeds up to 94.6% while Dual gold @ 2.50 lit ha^{-1} up to 90%.

Number of branches plant^{-1}: According to the results in Table 1, the number of branches has been significantly affected by the treatments in both the years of 2014 and 2015. Still, the mean number of branches was higher in 2015 than in 2014. The best reason could be the less weed infestation in 2015. The no. of branches plant^{-1} was highest (5.8 and 5.99) in Isoproturon 500 EW in 2014 and 2015, respectively which was followed by Parthenium extracts (4.3 and 5.66, respectively). The lowest number of branches plant^{-1} was 2.5 and 3.91 observed in weedy check plots. These discoveries are also in similarity with the results reported by Brain *et al.*, (1999) who observed maximum branches plant^{-1} in weed free plots. The obtaining of minimum value for branches plant^{-1} in the weedy check treatments clearly justified the importance of weeds losses in the chickpea fields, which showed that less no of branches in a plant ultimately lead to lower biological and seed yield. Malik *et al*., (2001) also had mentioned that there was less no. of branches plant^{-1} in weedy check plots than the control treatments.

Table 1. Weed density (m^{-2}) and no. of branches plant^{-1} as influenced by weed control techniques in chickpea crop during 2014 and 2015 at Karak Pakistan.

Treatments	Weed density (m^{-2})		Number of branches plant^{-1}	
	2014	2015	2014	2015
Dual Gold 960 EC	16.00 ef	38.41 bc	2.8 cd	4.07 c
Stomp 330 EC	41.00 cd	35.74 bc	2.6 d	5.58 ab
Topik 15 WP	47.00 c	18.74 c	3.2 cd	5.24 abc
Puma super 75 EW	88.00 b	46.33 bc	3.6 bc	4.24 bc
Parthenium extract	32.30 d	13.24 c	4.3 b	5.66 ab
Eucalyptus extract	28.00 de	34.41 bc	3.1 cd	4.74 abc
Isoproturon 500 EW	06.00 f	10.91 c	5.8 a	5.99 a
Hand Weeding	12.30 ef	12.83 c	3.0 cd	4.91 abc
Weedy check	268.30 a	102.57 a	2.5 d	3.91 c
$LSD_{0.05}$	14.40	27.3	0.850	1.50
Year effect	59.87 a	34.79 b	3.43 b	4.93 a

Means with different letters in the respective columns have significant difference at $\alpha = 0.05$ as per LSD test

Table 2. Number of pods plant^{-1} and number of seeds pod^{-1} as influenced by the weed control methods in chickpea crop during 2014 and 2015 at Karak Pakistan.

Treatments applied	No. of pods plant^{-1}		No. of seeds pod^{-1}	
	2014	2015	2014	2015
Dual Gold 960 EC	31.95 bc	27.74 c	1.35 ab	1.73 bcd
Stomp 330 EC	29.40 bc	40.66 ab	1.37 ab	1.50 e
Topik 15 WP	31.32 bc	31.91 bc	1.25 b	1.70 cd
Puma super 75 EW	35.00 ab	34.99 bc	1.35 ab	1.50 e
Parthenium extract	29.90 bc	31.33 bc	1.27 ab	1.83 bc
Eucalyptus extract	33.75 abc	31.16 bc	1.45 ab	1.86 b
Isoproturon 500 EW	41.47 a	47.33 a	1.55 a	2.00 a
Hand Weeding	31.95 bc	28.33 c	1.37 ab	1.60 de
Weedy check	24.52 c	25.66 c	1.22 b	1.33 f
$LSD_{0.05}$	9.240	11.85	0.29	0.146
Year effect	32.14 b	33.23 a	1.35 a	1.67 a

Means with different letters in the respective columns have significant difference at $\alpha = 0.05$ as per LSD test

Number of pods plant^{-1}: Similar to the weed density, the different treatments in both of the experimentation years had a significant effect on the no. of pods plant^{-1}. The data in Table 1 indicated that during 2014 and 2015 the highest no. of pods plant^{-1} was 41.47 and 47.33, respectively that was obtained in Isoproturon 500 EW applied plots; while the number of pods plant^{-1} was lowest (24.52 and 25.66, respectively) observed in the weedy check in both the years. While the results for the rest of the treatments were at par with each other statistically. The lowest no. of pods in the control plots was purely due to the highest level of competition of weeds with the crop plants. Our results are in conformity with the discoveries of Tanveer *et al.*, (2005) who obtained higher no. of pods plant^{-1} in herbicide treatments while lowest no. of pods plant^{-1} in the weedy check. These findings are in conformity with the findings of Marwat *et al*., (2005) and Abbas *et al.*, (2016) who mentioned that by controlling weeds with herbicides will ultimately increases no. of pods/plant.

Number of seeds pod^{-1}: The parameter of the no. of seeds plant^{-1} is an important feature in legume crops because the yield of seeds is totally dependent on the number and weight of seeds present in each pod. The results showed that the different treatments in both the years had a significant effect on the no. of seeds pod^{-1} (Table 2). The number of seeds pod^{-1} was highest (1.55 and 2.0) in plots of Isoproturon 500 EW, followed by the treatments of Eucalyptus extracts (1.45 and 1.86) during 2014 and 2015, respectively; while the lowest (1.22 and 1.33 seeds pod^{-1}) were observed in weedy check treatments. Similar type of results were presented by Mohamed *et al.*, (1997) and Taran *et al.*, (2013) who reported that unchecked weeds reduced the no. of seeds and the no. of branches plant^{-1} in the chickpea crop. However, Khan *et al*., (2010) reported a non-significant effect of pre-emergence herbicides on the no. of seeds pod^{-1} of chickpea.

Seed yield (kg ha^{-1}): The herbicides and weed extracts during both the years revealed a significant effect on seed yield along with significant effect of the years (Table 3). The results indicated that the highest yields of chickpea seeds (1356 and 1583 kg ha^{-1}) were obtained in treatments of Isoproturon 500 EW, followed by the application of Eucalyptus extracts (1320 and 1416 kg ha^{-1}); whereas, the seed yields of 960 and 1045 kg ha^{-1} were the lowest values recorded in untreated control plots during 2014 and 2015, respectively. In fact, such results were expected from the treatments because of the above mentioned highest per plant no. of pods and per pod no. of seeds recorded in the Isoproturon 500 EW treated plots. Similarly, there were lowest no of pods plant^{-1} and lowest no. seeds pod^{-1} in the control plots which resulted in lowest yields. Our results agreed with Khan *et al.*, (2010), who reported the lowest seed yield in control plots of chickpea crop. In another study, Sharma *et al*., (2001) achieved 21% decrease in the chickpea seed yield in the control/weedy check plots compared to the plots was extract were used. Similarly, Marwat *et al.*, (2005) have concluded that application of Stomp herbicide and hand weeding increased the seed yield of chickpea. Hassan & Khan (2007) also stated increase in the chickpea yield of 12-14% by the application of pre-emergence, and 6-23% by the application of post-emergence herbicides in chickpea crop.

Table 3. Seed yield (kg ha^{-1}) as influenced by the weed control methods applied in chickpea crop during 2014 and 2015 at Karak Pakistan.

Treatments	Seed yield (kg ha^{-1})	
	2014	2015
Dual Gold 960 EC	1213 ab	1208 ab
Stomp 330 EC	1299 a	1125 b
Topik 15 WP	1216 ab	1216 ab
Puma super 75 EW	1233 ab	1375 ab
Parthenium extract	1236 ab	1333 ab
Eucalyptus extract	1320 a	1416 ab
Isoproturon 500 EW	1356 a	1583 a
Hand Weeding	1253 ab	1366 ab
Weedy check	960 c	1045 b
$LSD_{0.05}$	339.2	403.6
Year effect	1231.7 b	1296.3 a

Means with different letters in the respective columns have significant difference at $\alpha = 0.05$ as per LSD test

Conclusions

From the two years research, it has been concluded that the herbicide Isoproturon 500 EW (isoproturon) is recommended as the post-emergence herbicide @ 125 g a.i. ha^{-1} for weed control in chickpea crop because it showed promising results regarding weed suppression and significantly increased the seed yield of chickpea crop. Beside the herbicide, the Eucalyptus extract can also be very effective as biological herbicide and environment friendly weed management tool in chickpea crop especially in the agro-ecological conditions of Karak, Khyber Pakhtunkhwa, Pakistan.

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