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Assessment of herbicides and mulches against weeds and yield of chickpea cultivars

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Abstract

To enhance crop yield by reducing weeds infestation has become one of the challenging aspects in agriculture. For this purpose a field study was conducted to check the efficacy of different weed control techniques in chickpea crop. Randomized Complete Block with split plot arrangement was the experimental design. Main plots were assigned with chickpea cultivars (Karak-I, Sheenghar and Karak-III) while different weeds control treatments were assigned to subplots respectively. Results showed that weeds infestation had significant impact on chickpea growth and yield. The findings revealed that hand weeding followed by commercial herbicides depicted least density and biomass for weeds while among mulch treatments, black plastic mulch presented superior control for weeds. Similarly the cultivar Karak-III presented sufficient competitiveness to weeds in comparison to other cultivars. Interaction of hand weeding and black plastic mulch with Karak-III cultivar displayed the significant results in term of growth and yield parameters. Economic analysis revealed that the utmost income to farmer (1:2.18) in term of added cost was obtained from Stomp 330EC fallowed by Dual Gold 960EC (1:1.94) and hand weeding (1:1.91) while among different mulch treatments the maximum cost benefit ratio (1:1.68) was recorded for black plastic mulch. Hence the present study concluded that hand weeding and herbicide i.e. Stomp 330EC obtain maximum weed control, high yield and net income. Correspondingly, in rainfed regions black plastic mulch could be a good option for successful weed management and positive impact on crop due to their additional benefit of moisture conservation.

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Introduction

Chickpea (*Cicer arietinum* L.) belongs to family Leguminosae, is a cool season crop and ranked 3rd among pulse legumes in the world (FAO, 2014). Crop is an imperative source of energy and protein uptake and plays vital role in daily nutrition of millions of people of central Asia (Abbo *et al.,* 2003). Its nitrogen fixation ability plays significant role in soil fertility management and encourages farmers to include it in crop rotation strategy (Maitin and Ebeling, 2001).

Being an important crop in term of human nutrition and soil health its yield is declining due to various factors. The key responsible constraints are inadequate moisture supplies and high weed infestation (Hussain *et al.,* 2015). In addition to all production constraints, weeds strongly add in chickpea yield decline as they are conventionally grown-up on lingering soil moisture. As a result their antagonism pose foremost trouble in water use efficiency. Yield losses due to weeds in chickpea ranged between 25-80% (Aslam *et al.,* 2007). The quality of chickpea seed can also be deteriorated by weed infestation which created storage problem along with market rate drop (Saxena, 1980).

For the effective weed control in field crops, various manual, chemical, cultural, biological and mechanical methods are applied. Mechanical methods *viz*., hand weeding is time consuming and backbreaking, whereas the unbroken herbicidal applications can leads to herbicide-resistant in weeds and has a downbeat impacts upon environment and human health (Vyvyan, 2002; Ihsan *et al.,* 2014). Among cultural methods, mulching is a recent and effective non-chemical weed control method with significant results (Mahmood *et al.,* 2015). Mulch is a material that covers the soil surface to protect and to improve the resource conservation. Primarily, mulches are of two types, i.e., organic mulch (living) and inorganic mulch (non-living). Organic mulch includes leaves, barks, woodchips, grass clipping etc. Organic mulch lowered soil temperature, increase soil moisture, decreased weed density and encourage crop yield (Sinkeviciene *et al.,* 2009; Mahmood *et al.,* 2015). Inorganic mulch includes polyethylene sheaths, pebbles, gravels etc (Sturrny, 1998). Mahajan *et al.* (2007) investigated significant increase in crop yield of plastic mulched plots over non-mulched soil. Straw mulching resulted in better grain yield and water use efficiency in different chickpea cultivars (Regar *et al.,* 2010).

Sometime chickpea varieties also facilitate infestation of different weed species. Some varieties are much tolerant while some are susceptible to weed infestation (Mousavi *et al.,* 2007). Likewise in several cases of chemical weed control method, herbicides residues have negatively affected the yield components and nodulation of susceptible varieties of chickpea (Datta *et al.,* 2009). While the judicious use of herbicides avoided yield losses caused by weeds and raised the yield of many crops including chickpea.

In light of the importance of chickpea and its yield losses owing to weeds infestation, the present study was initiated to appraise various mulching and herbicides for hampering weeds in chickpea with the objectives; (1) To study the efficacy of different herbicides and mulch strategies for controlling weeds in chickpea. (2) To figure out the effect of weed control strategies on chickpea growth and yield. (3) To investigate the interaction of cultivars with different weed management strategies.

Materials and methods

Experimentation

A field experiment was performed to investigate weed suppressing ability of different sources of mulches in *Cicer arietinum* L., under completely randomized design with split plot arrangement replicated thrice at New Developmental Farm, The University of Agriculture Peshawar during 2012-13. Three chickpea cultivars (Karak-I, Sheenghar and Karak II) were planted in main plots whereas weed management techniques including four different sources of mulches (black plastic, while plastic, saw dust and wheat straw) two commercial herbicides (Dual Gold 960 EC at the rate of 2 lit ha^{-1} and Stomp 330 EC at

the rate of 2.5 lit ha^{-1}), hand weeding and control were allotted in sub plots. The each subplot size was 4 m × 1.5 m with five rows and row to row distance was maintained at 30 cm apart. For attaining uniformity in germination, a light irrigation was applied just after seed sowing. Both herbicides were foliar sprayed with hand driven manual sprayer at recommended rates as pre-emergence treatment. While different mulches were applied just after seed emergence to encounter physical injury to seedlings. Weedy check plots were those where weeds were allowed to grow undisturbed while hand weeding was practiced thrice (30, 45 and 60 DAS) in manual weeded plots.

Crop husbandry

Experimental site was selected based on the previous history of high weed infestation. The field was ploughed twice followed by planking by tractor mounted plough. Chickpea was planted on 15 October 2012 by manual driven pore with a seed rate of 60 kg ha^{-1}. Field was irrigated at regular intervals as per the crop requirement.

Soil of experimental site belongs to silt loam. The pH of saturated soil paste was 7.8 and total soluble salts were 0.91 dS m^{-1}. Soil was low in organic matter (0.78%), total nitrogen (0.08%), available phosphorus (8.2 ppm) and potassium (185 ppm). A uniform basal dose of phosphorus and nitrogen at a rate of 40 kg ha^{-1} were applied at seed bed preparation. To minimize fertilizer effect, no fertilizer was applied at later stages of the growth. No insect or disease attack was noticed in all plots throughout the course of experimentation. Crop was manually harvested at physiological crop maturity. Grain yield was adjusted at 12% moisture content and economic analysis was performed accordingly.

Data recording

Weed density was measured by indiscriminately throwing 33 cm × 33 cm quadrate thrice in each subplot. The inside weeds of each quadrate were counted and identified. Mean was calculated and then was converted into density (m^{-2}). For calculating the weed fresh biomass, all weeds inside quadrate were harvested and immediately weighed (g m^{-2}) on electric balance.

The recorded data were changed into kg ha^{-1}. After taking fresh weight, weeds were dried in oven for 72 hours at 70 ^{o}C and then again weighed. The recorded data were subsequently converted to kg ha^{-1}. From each subplot ten representative plants were randomly chosen, tagged and their length was measured from base to tip in centimeters. Number of branches $plant^{-1}$, number of pods $plant^{-1}$ and number of seeds pod^{-1} were counted from ten tagged plants and their mean were used as single value. Grain weight, biological yield were measured in grams. The recorded data were subsequently transformed into kg ha^{-1}. Harvest index were measured and converted to percentage. Cost benefit ratio (CBR) were calculated by using following formula.

$$Cost - BenefitRatio = \frac{Addedincome}{Addedcost}$$

Statistical analysis

The recorded data was subjected to Fisher's analysis of variance (ANOVA) technique by using Statistic 8.1 (Analytical software, Statistic; Tallahassee, FL, USA, 1985-2003) and least significant difference (LSD) test at $p \leq 0.05$ was applied to compare treatments' means (Steel *et al.,* 1997).

Results

Weed growth

Effect of genotype (G), weed management strategies (WMS) and G × WMS interaction were highly significant ($p \leq 0.05$) for weed density, fresh and dry biomass accumulation.

The mean table 1 data showed that cultivars behaved variably in term of weed density and biomass accumulation as minimum density (123.67 m^{-2}), fresh (705.02 kg ha^{-1}) and dry (199.21 kg ha^{-1}) biomass was documented for Karak-III. The effect of subplot treatments (WMS) were greatly variable depending upon the nature of WMS, that was chemical or physical. The least weed density (98.67 m^{-2}) and biomass was perceived from hand weeded plots followed by chemical weed control treatments.

Table 1. Mean table for the effect of weed control treatments on weed density and agronomic parameters of chickpea cultivars.

Chickpea cultivars (C)	Weed Density (m^{-2})	Fresh biomass (kg ha^{-1})	Dry Biomass (kg ha^{-1})	Plant height (cm)	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	100 seed weight (g)	Bio Yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Harvest index (%)
Karak-I	137.04 a	729.11 b	209.39 b	58.88 b	5.57 b	25.60 b	19.81 b	4185.4 b	1318.3 b	30.85
Sheenghar	143.13 a	785.71 a	223.13 a	57.09 b	4.93 c	23.50 c	19.29 c	3788.6 c	1198.8 c	31.44
Karak-III	123.67 b	705.02 c	199.21 c	64.27 a	6.01 a	26.97 a	22.60 a	4509.7 a	1462.9 a	32.46
$LSD_{(0.05)}$	7.562	24.09	4.179	1.834	0.411	0.290	0.435	97.659	93.382	NS
Treatments (T)										
Black plastic mulch	122.78 d	691.78 e	203.51 d	64.11 b	6.50 b	30.73 a	24.43 b	4415.3 ab	1473.1 a	35.17 a
White plastic mulch	139.33 c	709.11 d	206.26 d	62.43 c	5.70 c	24.17 f	19.31 d	4240.9 bcd	1404.6 b	31.54ab
Saw dust mulch	154.11 b	728.78 c	215.16 c	58.46 e	5.00 e	22.43 g	17.11 f	3778.9 d	1191.9 d	29.69 cd
Wheat straw mulch	156.67 b	748.11 b	223.21 b	60.76 d	5.77 c	25.72 d	19.71 d	4314.7 bc	1415.2 b	32.87ab
Stomp 330 EC	100.67 e	669.56 g	194.42 e	57.14 e	5.28 d	27.41 c	21.66 c	4258.1bc	1413.8 b	32.84ab
Dual Gold 960 EC	104.67 e	687.89 f	200.13 de	57.10 e	4.78 f	24.72 e	18.03 e	4064.1 cd	1250.1 c	30.85bc
Hand weeding	98.67 e	655.33 h	172.46 f	69.16 a	6.68 a	28.74 b	27.07 a	4626.1 a	1491.6 a	32.30ab
Weedy check	200.00 a	1029.55 a	266.80 a	50.11 f	4.34 g	19.04 h	17.20 f	3605.7 d	979.8 e	27.76 d
$LSD_{(0.05)}$	7.308	2.13	6.187	1.659	0.196	0.437	0.5205	251.33	48.178	2.271
Interactions (C x T)	*	*	*	*	*	*	*	NS	*	*

Means of the same category followed by different letters are significantly different at P≤0.05 level using LSD test.
* = Significant, NS = Non-Significant.

The difference between chemical and physical weed control strategies was highly significant. Among different kinds of applied mulches, black plastic mulch suppressed maximum weeds as it produced the minimum weed density (122.78 m^{-2}), fresh (691.78 kg ha^{-1}) and dry biomass (203.51 kg ha^{-1}) accumulation that was still 9-20%, 2-7% and 1-7% higher than chemical weed control respectively. Two way interactions of G and WMS reported that least values for weed density (89.67 m^{-2}), fresh biomass (608.69 kg ha^{-1}) and dry biomass (144.96 kg ha^{-1}) was resulted by hand weeding × Karak-III among the applied treatments (Table 2). Likewise the weedy check and wheat straw mulch represented minimum weed control and highest accumulation ofweed biomass.

Table 2. Interaction of weed control treatmentsand chickpea cultivars on weed density, fresh and dry biomass accumulation.

Mulch Treatments	Weed density (m^{-2})			Weed fresh biomass accumulation (kg ha^{-1})			Weed dry biomass accumulation (kg ha^{-1})		
	Cultivars								
	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III
Black plastic	125.67 ij*	134.33 hi	108.33 klm	677.33 o	729.21 h	668.67 q	203.87 ghi	212.12 efg	194.55 jkl
White plastic	142.33 fgh	155.00 def	120.67 ijk	694.28 n	755.33 f	677.65 o	201.93 hij	219.68 de	197.16 ijk
Saw dust	155.67 de	166.33 cd	140.33 gh	721.31 j	767.15 e	697.67 m	214.13 efg	225.03 cd	206.32 fgh
Wheat straw	153.67 defg	170.00 c	146.33 efgh	741.33 g	778.24 d	724.66i	221.45 cde	231.37 c	216.82 def
Stomp 330 EC	101.00 lmno	112.00 jkl	94.01no	663.67 r	717.11 k	627.61 t	191.93 klm	208.66 fgh	182.66 mn
Dual Gold 960 EC	110.33 kl	104.33 lmn	99.33 lmno	675.25p	740.67 g	647.71 s	196.48 ijk	215.43 def	188.46 lm
Hand weeding	96.33 mno	104.00 lmn	89.67 no	647.67 s	709.63 l	608.69 u	177.01 n	195.41 jkl	144.96 o
Weedy check	211.33 a	199.00 ab	189.67 b	1012.11 b	1088.67 a	987.57 c	268.33 a	277.33 a	254.74 b
Cultivar × Mulch LSD	12.65			3.89			10.72		

* value with same letter are statistically non-significant at p≤0.05. LSD is least significant difference for treatments mean comparison.

Plant growth and yield

The main effect of G and WMS treatments were also highly significant (*p≤0.05*) for all growth and yield contributing traits except for harvest index that was non-significant for G. The two way interaction of WMS × G was also highly significant (*p≤0.05*) except for number of seeds pod^{-1} and biological yield (Table 3-5). Hand weeding resulted in the highest positive contribution to plant agronomic and yield related traits while weedy check produced the lowest values for the same. Amongchickpea cultivars, Karak-III cultivar perceived the tallest plant height (64.27 cm),

maximum number of branches plant^{-1} (6.01) and number of pods plant^{-1} (26.97) leaving behind Karak-I and Sheenghar (Table 1). Interaction of Karak-III cultivar to hand weeding also documented the maximum plant height (74.26 cm), number of branches (7.13), 100 seed weight (30.83 g) and seed yield (1590.3 kg ha^{-1}) that was statistically at par with black plastic mulch and significantly higher to chemical weed control treatments (Table 3-4). The number of seeds pod^{-1} reported non-significant results for interaction, however it was maximum for black plastic mulched plots for all three cultivars (Table 4).

Table 3. Interaction of weed control treatmentsand chickpea cultivars on plant height, number of branches and pods per plant.

Mulch Treatments	Plant height cm			number of branches plant^{-1}			pods plant^{-1}		
	Cultivars								
	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III
Black plastic	64.23 cde	61.06 efg	67.03 bc	6.36 c	6.25 cde	6.86 b	30.70 b	28.76 d	32.73 a
White plastic	63.46 de	59.47 fgh	64.36 cd	5.57 g	5.27 hi	6.25 cd	24.76 h	22.76 j	24.70 h
Saw dust	57.06 hij	55.24 jk	63.06 de	5.17 i	4.46 k	5.34 h	22.73 j	20.80 k	23.76 i
Wheat straw	59.07 gh	58.66 ghi	64.56 bcd	5.97 f	5.23 hi	6.13 def	25.70 g	23.76 i	27.70 e
Stomp 330 EC	56.05 ijk	55.30 jk	60.06 fgh	5.36 h	4.36 kl	6.10 ef	27.76 e	24.76 h	29.70 c
Dual Gold 960 EC	54.47 k	54.46 k	62.34 def	4.83 j	4.24 l	5.26 hi	24.70 h	23.76 i	25.70 g
Hand weeding	67.70 b	65.53 bcd	74.26 a	6.95 ab	5.96 f	7.13 a	28.73 d	26.70 f	30.80 b
Weedy check	48.93 l	46.96 l	54.44 ghi	4.35 kl	3.84 m	4.96 j	19.73 l	16.70 m	20.70 k
Cultivar × Mulch LSD	3.23			0.17			0.76		

* value with same letter are statistically non-significant at p≤0.05. LSD is least significant difference for treatments mean comparison.

Table 5 presented the data for biological yield, harvest index and treatments cost benefit ratio (CBR). Mean table data depicted that the utmost biological yield (4626.1 kg ha^{-1}) was recorded for hand weeding which was statistically at par with plastic mulching (4415.3 kg ha^{-1}). The overall results showed that physical treatments significantly showed higher values for biological yield and harvest index as compared to chemical weed control treatments (Table 1). As hand weeding attained maximum value for biological yield but significantly lower to physical weed control treatments for harvest index. Stomp 330EC was the second best treatment (in term of biological yield and harvest index) that followed black mulch treatment. Interactions of weed control treatments were superior with Karak-III cultivar as compared to rest.

Table 4. Interaction of weed control treatments and chickpea cultivars on seed number per plant, 100 seed weight and seed yield.

Mulch Treatments	number of seeds pod^{-1}			100 seed weight (g)			seed yield (kg ha^{-1})		
	Cultivars								
	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III
Black plastic	1.67	1.67	1.70	23.50 d	22.33 ef	27.46 b	1520.7 a	1326.3 c	1572.2 a
White plastic	1.28	1.28	1.47	19.66 i	17.51 klm	20.73 h	1310.0c	1285.5 c	1418.3 b
Saw dust	1.30	1.27	1.30	16.45 no	16.63 mno	18.23 jk	1092.7 e	1123.0 e	1360.0bc
Wheat straw	1.47	1.47	1.47	18.56 j	18.73 ij	21.83 fg	1405.1b	1246.3 d	1503.7 a
Stomp 330 EC	1.50	1.47	1.67	20.83 h	20.93 gh	23.23 de	1414.0 b	1330.7 c	1496.7 ab
Dual Gold 960 EC	1.30	1.27	1.47	16.21 o	17.22 lmn	20.63 h	1257.3 d	1122.0 e	1371.0bc
Hand weeding	1.47	1.67	1.70	25.66 c	24.73 c	30.83 a	1564.2 a	1310.0 c	1590.3 a
Weedy check	1.27	1.30	1.33	17.53 klm	16.20 o	17.83 jkl	971.1 f	946.7 g	1021.7 f
Cultivar × Mulch LSD	NS			0.94			83.44		

* value with same letter are statistically non-significant at p≤0.05. LSD is least significant difference for treatments mean comparison, NS means non-significant.

Economic analysis

Detailed description of economic analysis and net income based calculated CBR ratio is presented in Table 6. The highest treatment cost (40683 Rs) was perceived for saw dust mulch while least was spent for chemical weed control treatments. As the operational cost for crop husbandry was almost similar for all treatments thus based on the treatment cost variation, the maximum expenditure (75209 Rs) were calculated for saw dust mulch. Hand weeding yielded maximum produce of 1491 kg ha^{-1} while treatment with maximum experimental cost produced least grain yield (1192 kg ha^{-1}). Gross income was maximum for hand weeding while chemical weed control calculated the maximum net income.

Table 5. Interaction of weed control treatmentsand chickpea cultivars on biological yield, harvest index and CBR.

Mulch Treatments	Biological yield (kg ha^{-1})			Harvest index (%)			CBR		
	Cultivars								
	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III	Karak-1	Sheenghar	Karak-III
Black plastic	4488.0	3950.7	4807.3	33.88abc	33.59bc	38.04 a	1 : 1.50	1 : 1.36	1 : 1.66
White plastic	4188.4	4016.0	4518.3	31.28bcde	29.61cdef	33.74bcd	1 : 1.36	1 : 1.24	1 : 1.51
Saw dust	3622.1	3481.7	4192.7	26.72 f	30.53bcdef	31.81bcd	1 : 1.13	1 : 1.03	1 : 1.26
Wheat straw	4417.3	3860.3	4666.3	31.9 bcd	32.48bcd	34.24ab	1 : 1.21	1 : 1.09	1 : 1.34
Stomp 330 EC	4155.8	4078.1	4540.3	33.22bcd	33.09bcd	32.22bcd	1 : 2.03	1 : 1.84	1 : 2.25
Dual Gold 960 EC	4206.9	3683.1	4302.0	29.96bcdef	30.73bcdef	31.85bcd	1 : 2.05	1 : 1.86	1 : 2.27
Hand weeding	4842.3	4029.2	5006.7	32.52bcd	32.52bcd	31.85bcd	1 : 1.68	1 : 1.53	1 : 1.87
Weedy check	3562.7	3210.3	4044.3	27.35ef	29.01 def	26.93ef	-	-	-
Cultivar × Mulch LSD	NS			3.93					

* value with same letter are statistically non-significant at p≤0.05. LSD is least significant difference for treatments mean comparison, NS means non-significant, CBR is cost benefit ratio.

The CBR ratio was the highest for Stomp 330EC (1:2.18) as its gross income was lower but net income was higher as compared to hand weeded plots due to low treatment cost. Black plastic mulch gained higher net income among all physical weed control treatments thus recovered the maximum CBR ratio (1:1.68) (Table 6).

Table 6. Economics analysis for mulch treatments comparison and CBR ratio calculation.

Mulch treatments	Ploughing	DAP 2 bag ha^{-1}	Seed rate 60 kg ha^{-1}	Treatment cost	Harvesting cost	Threshing cost	Total expenditure	Total produce	Sale of grain *	Gross income	Net income	CBR ratio
Weedy check	23826	8000	3900	0	2400	1800	39926	979.8	65	63687	23761	1:1.59
Hand Weeding	23826	8000	3900	10800 a	2400	1800	50726	1491.6	65	96954	46228	1:1.91
Dual Gold 960 EC	23826	8000	3900	1800 b	2400	1800	41726	1250.1	65	81256	39530	1:1.94
Stomp 330EC	23826	8000	3900	2225 c	2400	1800	42151	1413.8	65	91897	49746	1:2.18
Wheat straw mulch	23826	8000	3900	30966 d	2400	1800	70892	1415.2	65	91988	21096	1:1.29
Saw dust mulch	23826	8000	3900	40683 e	2400	1800	75209	1191.9	65	77473	2264	1:1.03
White plastic mulch	23826	8000	3900	22866 f	2400	1800	62792	1404.6	65	91299	28507	1:1.45
Black plastic mulch	23826	8000	3900	17116 g	2400	1800	57042	1473.1	65	95751	38709	1:1.68

a: Hand weeding expenses of three men for four days for three times, b: Dual Gold 960 EC 2 lit ha-1 including application cost, c: Stomp 2.5 lit ha-1 = 2.5 x 650 including application cost, d: Wheat straw mulch expanses for 1ha including application cost, e: Saw dust mulch expanses. for 1ha including application cost, f: White plastic mulch expanses for 1ha including application cost, g: Black plastic mulch expanses for 1ha including application cost. * Sale of grain is 65 PKR per kg. PKR is Pakistani currency and 102 PKR is equal to 1 US$. All expenditures and income is calculated in PKR. CBR is cost benefit ratio.

Discussion

Among all the treatments, significant effects were shown by hand weeding and herbicides as the maximum weed control was obtained in hand weeding and herbicides treated plots. The lowest weed density and biomass accumulation in hand weeding plots were due to the poor weeds growth as a result of three times weeds removal whereas weedy

check plots were left untreated throughout growing season that result the highest weed density. Similarly the lower number of weeds (m^{-2}) in herbicides treated plots was due to the long persistence of chemicals in soil which inhibited weed seed to germinate. Our results are in strong conformity with those of Marwat *et al.* (2004) who stated that both hand weeding and herbicide were proved superior against weeds growth. Similarly in other study the importance of hand weeding and herbicides was also reported by Khaliq *et al.* (2013) and Patel *et al.* (2006) who found maximum weed control in treatments practiced with herbicides and hand weeding.

Similarly among all the mulch treatment the significant results were shown by black plastic mulch. The fact behind significant effect of black plastic mulch was the best performance due to three main facts i.e. conservation soil moisture, lowering soil temperature and effective control of weeds (Saeed *et al.,* 2013; Ramakrishna *et al.,* 2006). Also mulches promote soil biotic activities which reduce hard soil setting and contribute plant nutrients availability (Hashim *et al.,* 2013). For chickpea cultivars the fact behind the satisfactory results in Karak-III was its morphological characteristics which led to sufficient resources capturing capability, maximum branching, early maturity and weed tolerance capacity as compare to other tested chickpea cultivars. Likewise many researchers tested different chickpea cultivars and proved Sheenghar to be a poor competitor to weeds and having inferior agronomic characters (Yaqoob *et al.,* 2013). Current investigations are in correspondence with the results of Gul *et al.* (2011) who found the best growth, maximum branches and higher seed yield in Karak-III as compared to other chickpea cultivars.

The economic analysis revealed that all the practiced techniques significantly affect crop yield but varied in terms of input cost. Application of herbicides seems to be economical over rest of the treatments in term of weeds management and cost benefit ratio (CBR). On contrary, among different mulches, black plastic mulch has positively enhanced chickpea yield but due to high input cost the overall CBR was lower as compared to herbicides and manual weeding. Our study results are in line with those of Iqbal *et al.* (2010) and Chaudhary *et al.* (2011) who reported that among all the tested weed control techniques the maximum net income as a result of added cost was obtain from herbicides fallowed by hand weeding while the least income cost was obtained from saw dust and wheat straw mulches.

Conclusion

The present study concluded that hand weeding and tested Herbicide (Stomp 330EC) effectively control the weeds and obtain maximum seed yield while among chickpea cultivars the satisfactory results were obtained from Karak-III in term of weed control and yield relating parameters. Similarly among the emerging option for effective weed control is the use of different types of organic and inorganic mulches. In the light of foregoing results it was also concluded that among all the tested mulches along with different chickpea cultivars significant results were recorded for black plastic mulch in term of weed control and chickpea parameters.

Hence in rain fed regions plastic mulch is good option for successful weed management and benefiting the soil by conserving moisture for better crop growth. Similarly areas with high manpower suggested hand weeding for better weed control where as the areas with labor shortage are recommended to apply Stomp 330EC for achieving high crop yield in economical way.

Future perspective

Future work is suggested for crop management through environment friendly approach to check the efficacy of natural plants product (allelochemicals) with reduce doses of herbicides for effective weed control, reduce weeds resistance to herbicides and better crop yield.

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