__Original Research Article__

Effect ofDifferent Weed Management Practices on Growth Characters of Chickpea in Mid-hills of Himachal Pradesh

ABSTRACT

Chickpea (*Cicer arietinum*) is one of the most important pulse legumes in many parts of the world. India is largest producer of chickpea in the world, sharing 65 and 70 % of the total global area and production, respectively. Different weed control practices use of herbicides were followed for better management. Application of herbicide at critical growth stages followed by one or two hand weeding at proper time or manipulation of row spacing for improving the weed suppressing effect of crops gives marginal improvement in crop yield. A field experiment titled "Effects of Different Weed Management Practices on Growth Characters of Chickpea in Mid-hills of Himachal Pradesh" was conducted during *rabi* season of 2022 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction with EC in a safe range, medium in organic carbon, available nitrogen, potassium, and high in available phosphorus. The experiment was laid out in randomized block design with three replications comprising ten weed management treatments *viz*. (T_1) One hand weeding at 20 DAS, (T_2) Two hand weeding at 20 and 40 DAS, (T_3) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE), (T_4) Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS, (T_5) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + One hand weeding at 30 DAS, (T_6) Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS + One hand weeding at 40 DAS, (T_7) Fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} (PoE) at 25 DAS + One hand weeding at 40 DAS, (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS, (T_9) Weed free and (T_{10}) Weedy Check. The recommended dose of fertilizer (30:60:30 kg ha^{-1}) was applied through Urea, SSP, and MOP at the time of sowing. PBG-7 variety of chickpea was used for sowing. Weed management practices were done as per treatment. Other crop management practices were followed as per the recommendation of the area. Application of (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS registered higher growth parameters *viz.* plant height, number of branches $plant^{-1}$, dry matter accumulation and crop growth rate.

Key words: Chickpea, weed, herbicide, yield, PE, POE and B:C ratio

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the most important winter season pulse crop. It is a source of protein and it plays an important role in human nutrition for large population in the developing world. Chickpea is the second most important pulse crop after pigeon pea in the world for human diet and other use. Chickpea also plays a main role in increasing soil fertility due to its nitrogen fixing ability. Chickpea can fix up to 140 kg N ha^{-1} in a growing period (Poonia and Pithia, 2013). It leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improved soil health and fertility. Chickpea has been characterized into two main categories primarily on seed characteristics, the 'Desi' types, with relatively small, angular seeds with rough, usually yellow to dark brown testa, constitute about 85% of annual world production and are confined entirely to the Indian sub-continent, Ethiopia, Mexico and Iran. The 'Kabuli' types, which have larger more rounded and creamed colored seeds, comprise only a minor area and production, but account entirely for the crops of Europe and the America, except Mexico. It ranks first in area cultivated in India, grown over an area of 9.85 million ha with production of 11.99 million tones and average productivity of 1217 kg ha^{-1} (Agricultural Statistics at a Glance, 2021- 22). Madhya Pradesh, Maharashtra, Rajasthan, Gujarat, Uttar Pradesh, Andhra Pradesh and Karnataka are the major chickpea producing states sharing over 95% area.

Himachal Pradesh state has good agro-ecological situation for chickpea production but the average productivity is very less than other states. In chickpea production, one of the major constraints is weed infestation. Weeds compete with crop plants for space, water and nutrients and hence, it causes considerable yield losses. Thus, weeds are one of the major constraints to obtain high grain yield of improved crop cultivars if they are not controlled timely and properly. Chickpea is poor competitor to weeds because of slow growth rate and limited leaf development at early stage of crop growth and establishment, if weed management is neglected under these conditions, resulting in yield loss of 40 to 87% (Ratnam *et al*., 2011). Weeds emerge with the winter sown crop and create severe competition unless controlled timely and effectively. Yield losses due to weed competition vary considerably depending on the levelof weed infestation and weed species prevailing. The important weed flora of chickpea includes *Chenopodium album, Medicago denticulata, Echinocloa colona, Parthenium hysterophorus* and *Cynodon dactylon*. Hand weeding and mechanical weed control methods traditionally followed in the developing countries are becoming expensive due to increased labor wages. Because of the sensitivity of chickpea to herbicides, most effective are the pre-emergence, and choices for post-emergence herbicides are limited. The pre-emergence herbicides are effective in controlling weeds at early stage of seedling growth, but weeds germinating after crop emergence become dominant in the field and cause substantial yield losses. Therefore, chickpea cultivars with improved herbicide tolerance, which can offer greater flexibility for use of post-emergence herbicides, are required by the farmers. Weed infestation in chickpea offer serious competition and cause yield reduction to the extent of 75% (Chaudhary *et al.* 2005). Weed management through herbicides is needed even in the developing countries, such as India, to make chickpea cultivation more profitable. Initial 60 days is the period considered too critical for weed crop competition in chickpea (Singh and Singh, 2000). Weed management through herbicides is not only economical but also facilitates zero tillage or minimum tillage methods, which help in practicing conservation agriculture. Chemical control of weeds also involves various options; pre-planting treatment is applied before crop is sown, where the herbicides used are acting on germinating seedlings. Pre emergence treatments are applied after seeding but before the crop emerges, chemicals may control weeds by killing weed seedlings. While, post-emergence herbicides are applied after the emergence of crop plants and weeds, with selective herbicides.weeds are killed with little damage to crop plants due to differential tolerance of the crop and weed to the herbicides. Chickpea is known to be sensitive to many herbicides and, therefore, choices for using post-emergence herbicides for weed control are limited. Within the limited available herbicide options, the main chickpea herbicide Pendimethalin are registered only for pre-emergent use. Pendimethalin has been registered for use in chickpea in Canada. No post-emergence herbicide has been recommended for weed control in chickpea in South Asia where bulk of chickpea is grown. This is mainly because the available chickpea cultivars are sensitive to herbicides. Up to 1 kg ha^{-1} Pendimethalin is registered for pre-emergent use on chickpeas. Many research workers from the various parts of the country have reported that the application of pendimethalin as pre-emergence at 1.0 kg ha^{-1} (Singh and Jain, 2017). Chickpea varieties are sensitive to Pendimethalin applied post emergence. Lack of effective post-emergent herbicide options in chickpea poses difficulties in managing weeds which emerge after sowing. The imidazolinone class of herbicides provides a broad spectrum of weed control activity, flexibility in timing of application, low usage rates and low mammalian toxicity. Imazethapyr is an herbicide belongs to imidazolinone class, applied as pre-plant incorporation, pre-emergence and early-post emergence for control of annual grass, broad- leaf weeds and perennial sedges in chickpea and other legume fields.

2. MATERIALS AND METHODS

The fieldwork was done in the *rabi*season of 2022 at at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan which is situated at a latitude 30^0 85’67.30 N and longitude 77^0 13’20.38 E and an elevation of 1284 meters above mean sea level (AMSL). The experiment was laid out in randomized block design with three replications and ten weed management treatments *viz.*

Experimental Design

(T_1) One hand weeding at 20 DAS,

(T_2) Two hand weeding at 20 and 40 DAS,

(T_3) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE),

(T_4) Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS,

(T_5) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + One hand weeding at 30 DAS,

(T_6) Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS + One hand weeding at 40 DAS,

(T_7) Fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} (PoE) at 25 DAS + One hand weeding at 40 DAS,

(T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + Imazethapyr 10 SL @ 1.0 kg ha^{-1} (PoE) at 25 DAS,

(T_9) Weed free and

(T_{10}) Weedy Check.

The soil of experimental field was sandy loam in texture, slightly alkaline in reaction with EC in safer range, medium in organic carbon, available nitrogen, potassium and high in available phosphorus. The chickpea variety PBG-7 was sown on 8th November, 2022 at a row spacing of 30 × 10 cm using seed rate of 75 kg ha^{-1} and Recommended dose of nitrogen, phosphorus and potassium (30:60:30 kg ha^{-1}) through urea, SSP and MOP at time of sowing. All the data were subjected to analysis of variance (ANOVA) as per the standard procedures. The comparison of treatment means was made by critical difference (RBD) at p=0.05.

3. RESULTS AND DISCUSSIONS

3.1 Plant height (cm)

Plant height is a reliable index of growth and development representing the infrastructure build-up over a period of time. Periodic plant height recorded at 30, 60, 90 days after sowing (DAS) and at harvest is presented in Table 1. The data showed that plant height continued to increase with the advancement of crop age and this increase was rapid during early crop growth period and thereafter, a slow rate of increase in plant height was observed.

Different weed management practices had significant effect on plant height at allcrop growth stages during investigation. At 30 DAS, treatment (T_9) weed free recorded significantly higher plant height at all the crop growth stages recorded during experimentation. Among the weed management practices, herbicidal application of (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} as pre emergence + Imazethapyr 10 SL @ 1.0 kg ha^{-1} as post emergence at 25 DAS recorded significantly higher plant height (13.01 cm) at 30 DAS over rest of the treatments. However, least plant height was noted under (T_{10}) weedy check treatment. Similar, trend was also observed at 60, 90 DAS and at harvest stage during course of study.Sharma *et al.* (2005) propose that the increased plant height is potentially a result of effective weed management, which minimizes competition between weeds and the main crop for essential resources such as light, nutrients, and moisture. Consequently, the successful control of weeds leads to decreased competition, fostering an overall enhancement in crop growth. In a weedy condition, weeds take a bigger portion of the resources available in the soil and environment for their growth during the early stages of crop growth. According to Tiwari *et al.* (2018), the highest plant height might be due to the better weed management and minimizing the competition of weeds with main crop for resources *viz.*, light, nutrients and moisture with those effective weed control treatments. Thus, reduced crop-weed competition resulted into overall improvement of crop growth as measured by plant height, which led to better reproductive structure and translocation of photosynthates to the sink. The results corroborated with the findings of Yadav *et al.* (2014).

3.2 Number of branches plant^{-1}

The number of branches plant^{-1} area recognized as crucial determinant thatmarkedlyaffect the yield of crops. Branches plant^{-1}were recorded periodically at 60, 90 DAS and atharvest (Table 2) and data revealed that number of branches plant^{-1} showedincreasingtrend up to 90DAS.

Numberofbranchesplant^{-1}weresignificantlyaffectedsignificantlyduetoweedmanagement practices at all crop stages during course of investigation. Treatment (T_9) weedfree recorded significantly higher number of branches plant^{-1} at all thecrop growth stagesrecordedduringexperimentation.DatapresentedinTable4anddepictedinFig.1 revealed that the significantly higher number of branches plant^{-1} (9.86), (16.58) and (17.68) at30, 60 and 90 DAS, respectively recorded with herbicidalapplication of (T_8) Pendimethalin30 EC @ 1.0 kg ha^{-1}as pre emergence+Imazethapyr10 SL @1.0 kg ha^{-1}as postemergence applied at 25 DAS. Application of (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} as preemergence+Imazethapyr10SL@1.0kgha^{-1}aspostemergenceat25DASwasstatistically at par with (T_2) Two hand weeding at20 and 40 DAS and (T5) Pendimethalin 30EC@1.0kgha^{-1}aspreemergence+Onehandweedingat30DAS.However,leastnumber of branches plant^{-1} was noted under (T_{10}) weedy check treatment at all crop growth stagesstudied.Grishin (2001) reported a great demand for light, space, moisture and nutrients by plants with similar morphology and physiology. In agreement with present result, (Hock *et al.*, 2006) found differences in number of branches due to various intensities of weed competition with crop plants.

3.3 Dry matter accumulation plant^{-1} (g)

Dry matter accumulation is an important index indicating the photosynthetic efficiency of the crop which ultimately influences the crop yield. It is a direct index of plant proliferation. Dry matter accumulation increased progressively with advancement in crop age as presented in Table3. Dry matter accumulation varied significantly in response to weed management practices at all stages. Crop accumulated dry matter at faster rate upto 90 DAS and thereafter, slower rate was reported.

Dry matter accumulation varied significantly due to weed management practices. Treatment (T_9) weed free recorded significantly higher dry matter accumulation plant^{-1} during experimentation. Further, from the data it is clear that significantly higher dry matter accumulation (8.51 g plant^{-1}) recorded with herbicidal application of (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} as pre emergence + Imazethapyr 10 SL @ 1.0 kg ha^{-1} as post emergence at 25 DAS which was statistically at par with (T_2) Two hand weeding at 20 and 40 DAS and (T_5) Pendimethalin 30 EC @ 1.0 kg ha^{-1} as pre emergence + One hand weeding at 30 DAS, respectively at 30 DAS during experimentation. Similar trend was also noted at 60, 90 DAS and at harvest stage. However, least dry matter accumulation plant^{-1} at all crop growth stages were recorded with (T_{10}) weedy check treatment during experimentation. This was due to the effective control of weeds, less crop weed competition throughout the crop growth period and due to better control of both grassy as well as broad-leaved weeds during early crop growth period which resulted in improved dry matter accumulation of the crop (Yadav *et al.*, 2015 and Singh *et al.*, 2016).

3.4 Crop growth rate (g plant^{-1} day^{-1})

Crop growth rate is completely depends on dry matter accumulated by crop plants.CropgrowthrateincreasedprogressivelywithadvancementincropageaspresentedinTable 4. It was varied significantly in response to weed management practices at allstages. Crop accumulated growthrate at faster rate upto 60- 90 DAS and thereafter, slowerratewasreported.

Crop growth rate varied significantly due to weed management practices. Treatment(T_9) weed free recorded significantly higher crop growth rate recorded duringexperimentation. Further,fromthedataitisclearthatsignificantlyhighercropgrowthrate(0.28gplant^{-1}day^{-1}) at 0-30 DAS was noted under herbicidal application of (T_8) Pendimethalin 30 EC @ 1.0 kgha^{-1} as pre emergence + Imazethapyr 10 SL @ 1.0 kg ha^{-1} as post emergence at 25 DASwhichwasstatisticallyatparwith(T_2)Twohandweedingat20and40DAS,(T_5)Pendimethalin 30 EC @ 1.0 kg ha^{-1} as pre emergence +One hand weeding at 30 DAS and (T_6) Imazethapyr 10 SL @ 1.0 kg ha^{-1} as post emergence at 25 DAS + One hand weeding at 40DAS, respectively during experimentation. Similar trend was also noted at 30-60, 60-90 DASand 90 DAS to at harvest stage. However, least crop growth rate plant^{-1} at all crop growthstageswererecorded with(T10) weedycheck treatmentduringexperimentation.This can be attributed to the successful management of weeds, reduced competition between the crop and weeds throughout the crop growth cycle, and improved control of both grassy and broad-leaved weeds during the early stages of crop growth. These factors collectively led to enhanced yield characteristics for the crop (Yadav *et al.*, 2015 and Singh *et al.*, 2016).

Table 1:Plantheight(cm)of chickpeaasinfluencedbyweedmanagementpracticesatperiodicintervals

Treatments	**Plantheight(cm)**			
	30DAS	**60DAS**	**90DAS**	**Atharvest**
T1:Onehandweedingat20DAS	11.45	26.15	50.12	49.57
T2:Twohand weedingat20and 40DAS	11.65	29.67	53.27	52.67
T3: Pendimethalin 30 EC@ 1.0kgha^{-1}(PE)	11.45	25.98	49.65	48.57
T4:Imazethapyr 10SL@ 1.0kgha^{-1}(PoE)at 25DAS	10.95	26.02	50.02	49.67
T5:Pendimethalin30 EC@ 1.0kgha^{-1} (PE)+Onehand weedingat 30DAS	11.62	28.97	53.11	52.34
T6:Imazethapyr10SL@ 1.0 kgha^{-1}(PoE)at25DAS +Onehandweedingat 40 DAS	10.98	28.12	52.87	51.67
T7:Fenoxaprop-p-ethyl 9.3 EC @ 60 gha^{-1}(PoE)at25 DAS + One handweedingat 40DAS	10.21	27.87	51.92	50.39
T8:Pendimethalin 30 EC@ 1.0 kgha^{-1}(PE)+Imazethapyr10SL@ 1.0 kgha^{-1}(PoE) at 25 DAS	13.01	30.56	54.12	53.28
T9:Weedfree	13.25	31.24	58.97	57.91
T10:WeedyCheck	8.69	21.17	43.18	42.38

SEm±	0.36	0.73	1.38	1.32
LSD(*p*=0.05)	1.11	2.16	4.21	4.17

Table 2: Number of branches plant^{-1} of chickpea as influenced by weed management practices at periodic intervals

Treatments	Numberofbranchesplant^{-1}		
	60DAS	**90DAS**	**Atharvest**
T1:Onehandweedingat20DAS	8.11	14.68	15.64
T2:Twohand weedingat20and 40DAS	9.18	16.02	17.65
T3: Pendimethalin 30 EC@ 1.0kgha^{-1}(PE)	7.56	14.02	15.34
T4:Imazethapyr 10SL@ 1.0kgha^{-1}(PoE)at 25DAS	7.89	14.21	15.38
T5: Pendimethalin 30 EC@1.0 kgha^{-1}(PE)+ Onehand weedingat30 DAS	8.94	15.67	15.96
T6:Imazethapyr 10SL@1.0 kgha^{-1} (PoE)at25DAS +Onehandweedingat40DAS	8.79	15.42	16.57
T7: Fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} (PoE) at 25 DAS + One handweedingat 40 DAS	8.51	15.11	16.24
T8: Pendimethalin 30 EC @ 1.0 kg ha^{-1} (PE) + Imazethapyr 10 SL @ 1.0 kgha^{-1} (PoE)at 25 DAS	9.86	16.58	17.68

T9:Weedfree	10.27	18.67	19.52
T10:WeedyCheck	6.10	10.12	11.23
SEm±	0.33	0.56	0.54
LSD(p=0.05)	1.05	1.72	1.68

Table 3:Drymatteraccumulationplant^{-1}(g)ofchickpeaasinfluencedbyweedmanagementpracticesatperiodicintervals

Treatments	Dry matteraccumulationplant^{-1}(g)			
	30DAS	60DAS	90DAS	Atharvest
T1: Onehandweedingat20DAS	7.11	35.12	70.59	84.71
T2: Twohand weedingat20and 40DAS	8.14	37.11	80.53	97.44
T3: Pendimethalin 30 EC@ 1.0 kgha^{-1}(PE)	6.51	34.54	63.21	75.22
T4: Imazethapyr 10SL@ 1.0kgha^{-1}(PoE)at 25DAS	6.87	34.98	68.56	82.96
T5: Pendimethalin30 EC@ 1.0kgha^{-1} (PE)+Onehand weedingat 30DAS	7.91	36.87	78.90	97.84
T6: Imazethapyr 10SL@1.0 kgha^{-1}(PoE)at 25DAS +Onehandweedingat 40 DAS	7.54	36.13	76.60	94.98

T7: Fenoxaprop-p-ethyl 9.3 EC @ 60 gha^{-1}(PoE)at25 DAS +One handweedingat 40DAS	7.32	35.68	73.86	90.11
T8: Pendimethalin 30 EC@ 1.0 kgha^{-1}(PE)+Imazethapyr 10SL@ 1.0 kgha^{-1}(PoE) at 25 DAS	8.51	38.69	84.34	105.43
T9: Weedfree	8.87	40.12	88.67	111.72
T10:WeedyCheck	4.11	27.56	54.29	67.86
SEm±	0.23	1.00	2.04	1.97
LSD(p=0.05)	0.72	3.04	6.15	5.96

Table4:Cropgrowthrate(gplant^{-1}day^{-1})ofchickpeaasinfluencedbyweedmanagement practicesatperiodicintervals

Treatments	Cropgrowth rate(g plant^{-1}day^{-1})			
	0-30DAS	30-60DAS	60-90DAS	90DAS-At harvest
T1: Onehandweedingat20DAS	0.24	0.93	1.18	0.71
T2: Twohand weedingat20and 40DAS	0.27	0.97	1.45	0.85
T3: Pendimethalin 30 EC@ 1.0 kgha^{-1}(PE)	0.22	0.93	0.96	0.60
T4: Imazethapyr 10SL@ 1.0kgha^{-1}(PoE)at 25DAS	0.23	0.94	1.12	0.72

T5: Pendimethalin30 EC@ 1.0kgha^{-1} (PE)+Onehand weedingat 30DAS	0.26	0.97	1.40	0.95
T6: Imazethapyr 10SL@1.0 kgha^{-1}(PoE)at 25DAS +Onehand weedingat 40 DAS	0.25	0.95	1.35	0.92
T7: Fenoxaprop-p-ethyl 9.3 EC @ 60gha^{-1}(PoE)at 25 DAS+ One handweedingat 40DAS	0.24	0.95	1.27	0.81
T8: Pendimethalin 30 EC@ 1.0 kgha^{-1}(PE)+Imazethapyr 10SL@ 1.0 kgha^{-1}(PoE) at 25 DAS	0.28	1.01	1.52	1.05
T9:Weedfree	0.30	1.04	1.62	1.15
T10:WeedyCheck	0.14	0.78	0.89	0.68
SEm±	0.01	0.03	0.03	0.02
LSD(*p*=0.05)	0.03	0.09	0.11	0.08

CONCLUSIONS

Application of (T_8) Pendimethalin 30 EC @ 1.0 kg ha^{-1} as pre emergence + Imazethapyr 10 SL @ 1.0 kg ha^{-1} as post emergence at 25 DAS registered higher growth parameters *viz*. plant height, number of branches $plant^{-1}$, dry matter accumulation and crop growth rate.

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