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Effect of Different Weed Control Measures on Performance of Chickpea under Irrigated Condition

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A B S T R A C T

The field experiment was conducted during *Rabi* season of the year 2011-12 at Agronomy Research Farm of N.D. University of Agriculture and Technology, Faizabad, Uttar Pradesh to find out most suitable weed management practice in chickpea. The experiment was laid out in randomized block design with three replications and fourteen weed control treatments, *viz.* pendimethalin 1000g ha^{-1} [Pre-emergence (PE)], pendimethalin 1000 g ha^{-1} (PE) followed by (*fb*) quizalofop-ethyl 60 g ha^{-1} [Post-emergence (PoE)], pendimethalin 1000g ha^{-1} (PE) *fb* clodinafop 60 g ha^{-1} (PoE), pendimethalin (PE) 750 g ha^{-1}*fb* quizalofop-ethyl 60g + oxyfluorfen 200g ha^{-1} (PoE), oxyfluorfen 200g ha^{-1} (PE), oxyfluorfen 200g ha^{-1} (PE) *fb* quizalofop-ethyl 60g ha^{-1} (PoE), oxyfluorfen 200g ha^{-1} (PE) *fb* clodinafop 60g ha^{-1} (PoE), oxyfluorfen 200g + quizalofop-ethyl 60g/ha (PoE), oxyfluorfen 200g + clodinafop 60g ha^{-1} (PoE), imazethapyr 75g ha^{-1} (PoE), pendimethalin 1000g (PE) *fb* imazethapyr 75g ha^{-1} (PoE), pendimethalin 1000g ha^{-1} (PE) *fb* imazethapyr 75g + quizalofop-ethyl 60g ha^{-1} (PoE), weed free and weedy check. Results indicated that weed control treatments give significantly positive impact on number of nodules, nutrient (N, P, K) uptake, yields and economics of chickpea over weedy check at each growth stage. Maximum yield (1.72 t ha^{-1}) and nutrient uptake (N- 63.60, P- 9.09 and K- 74.39kg/ha) by chickpea were recorded in weed free treatment but maximum nitrogen, phosphorous and potassium (23.22, 2.68 and 50.42kg/ha) uptake by weed were obtained in weedy check treatment and lowest in weed free treatment. So, adoption of suitable weed management measures can enhance the performance of crop and provide more income to farmers far achieving the goal of doubling farmer income by 2022.

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crop of our country, in India area, production and productivity of chickpea are the 8.17 million hectares, 7.48 million tonnes and 915 kgha^{-1}, respectively and in Uttar Pradesh it is cultivated on an area of 0.62 million hectares with a production 0.51 million tonnes and productivity 824 kgha^{-1}. The area under chickpea crop has reduced to 0.60 million hectares in 2014-15 from 1.06 million hectares in 1966-67 (Anonymous 2016) due to slow initial growth and it suffers

badly by severe competition with weeds for nutrients, light, water and space. About 40-45% reduction in yield of chickpea due to severe infestation of weeds was estimated by Singh and Singh (1992) while, Chaudhary *et al.,* (2005) reported 75% of yield reduction because of serious competition of chickpea crop with weeds. Poor weed management is one of the most important yield limiting factors in chickpea, some other factors are brackish irrigation water, hungry and discarded soils, lack of promising cultivars, improper fertilization, pest and diseases are responsible for much reduction in yield of chickpea. The initial 60 days' period considered to be the critical for weed crop competition in chickpea (Singh and Singh 1992) But continuously facing of the scarcity of labour and increase in labour cost, manual weed control has become a difficult task. Suitable herbicide for effective control of mixed weed flora is required for better adoption in this crop by farmers. Introduction of herbicides has made it possible to control a wide spectrum of weeds in pulses effectively at a remunerative cost. Many research workers from the various parts of the country has been reported that the application of pendimethalin as pre-emergence at 1.0 kg ha^{-1} (Tewari *et al.,* 2003 and Vaishya *et al.,* 2005), imazethapyr as post-emergence at 0.1 kg ha^{-1} (Singh *et al.,* 2003), cloinafop-propargyl (Topic 15 WP)as post-emergence at 0.03 kg ha^{-1} (Marwat *et al.,* 2004) and oxyfluorfen (600 g ha^{-1}) as weed control treatment (Yousefi *et al.,* 2007) provided effective control of annual broad leaved and grassy weeds in chickpea field.

In the legumes especially in case of chickpea pendimethalin at 1000 g ha^{-1} applied as pre-emergence is a very common herbicide which is used to take care of all type of weeds, but there is no herbicide available to applied as post-emergence to control the emerging BLWs effectively. Even if pre-emergence application of herbicide is missed due to any reason in that case post-emergence herbicide application to control the grassy as well as non-grassy weeds is very much required. So far, no herbicide is available which can be used to control the weeds especially BLWs by applying as post-emergence in pulses and more specifically in chickpea. However, manual weeding has been found very efficient but availability of labours at required time and at more rates has become a serious question. The chickpea, although is an important *rabi* pulse crop yet no adequate information on effective weed management are available especially for eastern part of Uttar Pradesh where sowing of chickpea is further delayed due to many problems. In the present time, some of the very effective high potency herbicide molecules have been developed which may be useful to control the wide spectrum of weeds in chickpea further, if their molecules are used in a combination may be more effective to control the wide spectrum weeds.

Hence, present investigation was carried out to study the efficacy of different herbicides on mixed weed flora and their effect on growth and yield of chickpea. In chickpea weeds germinate and grow fast in many flushes so, application of one herbicide alone is not much effective and economical weed control measure under such condition. Keeping in view this fact, a field trial having the sequential and tank mixed application of two or more herbicides was proposed to find out the suitable and effective weed management practice during critical period of crop-weed interference in chickpea.

Materials and Methods

Experimental site

The field experiment was conducted during *Rabi* season of the year 2011at Agronomy Research Farm of N.D. University of

Agriculture and Technology, Faizabad (U.P.) India, situated at 26^0 47' N latitude, 82^0 12' E longitude and an altitude of 113 meters above from mean sea level. Mean of minimum and maximum temperatures ranged from 5.0^0 C to 15.1^0 C and 15.3^0 C to 32.1^0C respectively while, total rainfall received during the crop season was 86.0 mm. The soil of the experimental field was silt-loam, low in organic carbon (0.37), available nitrogen (176.0 kg ha^{-1}), phosphorus (15.20 kg ha^{-1}), medium in potash (210.0 kg ha^{-1}) and alkaline in reaction (pH- 8.1).

Experimental treatments

Chickpea variety "PG-186" was sown in rows, at 40 cm apart and at 4-5 cm deep. The experiment was laid out in randomized block design with fourteen weed control treatments, *viz.* pendimethalin 1000g ha^{-1} [Pre-emergence (PE)], pendimethalin 1000 g ha^{-1} (PE) followed by (*fb*) quizalofop-ethyl 60 g ha^{-1} [Post-emergence (PoE)], pendimethalin 1000g ha^{-1} (PE) *fb*clodinafop 60 g ha^{-1} (PoE), pendimethalin (PE) 750 g ha^{-1} *fb*quizalofop-ethyl 60g + oxyfluorfen 200g ha^{-1} (PoE), oxyfluorfen 200g ha^{-1} (PE), oxyfluorfen 200g ha^{-1} (PE) *fb*quizalofop-ethyl 60g ha^{-1} (PoE), oxyfluorfen 200g ha^{-1} (PE) *fb*clodinafop 60g ha^{-1} (PoE), oxyfluorfen 200g + quizalofop-ethyl 60g/ha(PoE), oxyfluorfen 200g + clodinafop 60g ha^{-1} (PoE), imazethapyr 75g ha^{-1} (PoE), pendimethalin 1000g (PE) *fb*imazethapyr 75g ha^{-1} (PoE), pendimethalin 1000g ha^{-1} (PE) *fb*imazethapyr 75g + quizalofop-ethyl 60g ha^{-1} (PoE), weed free and weedy check. Two hands weeding was done in weedy check and weed free plot and experiment was carried out with three replications. Recommended package of practices except weed control treatments were followed for raising the crop. A uniform dose of fertilizers 20:40:40N, P_2O_5, K_2O kg ha^{-1} was applied at the time of sowing in furrows. Pre-plant incorporation and pre-emergence herbicides were applied one day before and after sowing, respectively using a knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 litres of water per hectare. Hand weeding was done with the help of *khurpi* when required in weed free treatment. Number of nodules ware recorded at 45^{th}, 60^{th}, 75^{th}, 90^{th} day stages of crop growth. After harvesting yield of crop calculated by per plot basis and then it converted into t ha^{-1} after that economics of different treatments was calculated.

Results and Discussion

Effect of weed control measures on number of root nodules

All the weed-control measures had significantly positive impact on number of root nodules of chickpea over weedy check at each growth stage (Fig. 1). Highest number of root nodules observed in weed free plot over weedy check and in herbicide treated plot there was less number of root nodules at 45, 60, 75 and 90 DAS. At 45 and 90 DAS the lowest number of root nodules observed in post-emergence application of oxyfluorfen 200g *fb* byclodinafop 60gha^{-1}at 35 DAS. And 60 and 75 DAS the lowest number of root nodules observed in post- emergence application of oxyfluorfen 200g ha^{-1} (PE) at 30 DAS (Sharma. 2009). This results ware might be due to toxic effect of herbicide on chickpea which affect the development of nodules in roots.While in case of better weed control treatments, weed free condition provided professed root development and bacterial colonies, which ultimately resulted in more nodulation in crop. Almost similar trend was recorded at 60^{th} day stage also. In case of 75^{th} and 90^{th} day stages, declined the number of nodules $plant^{-1}$, respectively due to cessation of nodulation and started drying of nodules. The results are in agreement with the finding of Vaishya *et al.,* (1995).

Effect of weed control measures on nutrient uptake by chick pea and weeds

Maximum nitrogen, phosphorous and potassium (63.60, 9.09 and 74.39 kg ha^{-1}) uptake by chickpea were recorded in weed free treatment (Fig. 2) and among the herbicidal treatment minimum nutrient, Nitrogen (18.71 kg ha^{-1}) and potassium (22.63 kg ha^{-1}) uptake in pre- emergence of pendimethalin 750 g followed by combined post-emergence application of quizalafop 60g + oxyfluorfen 200g ha^{-1} at 35 DAS and Phosphorous (2.61 kg ha^{-1}) uptake in post-emergence of oxyfluorfen 200g + quizalofop 60gha^{-1} at 35 DAS. But maximum nitrogen, phosphorous and potassium (23.22, 2.68 and 50.42kg ha^{-1}) uptake by weed (Fig. 3) were in weedy check treatment and lowest in weed free treatment.

Among the herbicidal treatment minimum nutrient (nitrogen, phosphorous and potassium) (1.86, 0.21 and 3.86 kg ha^{-1}) uptake in pre-emergence application of pendimethalin 750 g (PE) followed by combined post-emergence application of quizalafop 60g + oxyfluorfen 200g ha^{-1} at 35 DAS (Patel *et al.*, 2016). It might be due to the more dry-weight and nutrients content in BLWs as compared to grassy weeds. These results are in the conformity with the work of Azad and Singh (1997).

Effect of weed control measures on dry weight and 100-grain weight of crop

Crop dry matter accumulation was increased appreciably due to the different treatments as compared to the weedy check as all the growth stages of crop. As far as the treatment combinations were concerned, they showed higher dry matter accumulation as compared to application of single treatment, except some in which crop phytotoxicity was noticed.

Fig.1 Effect of weed control treatments on number of nodules per plant at different days of chickpea

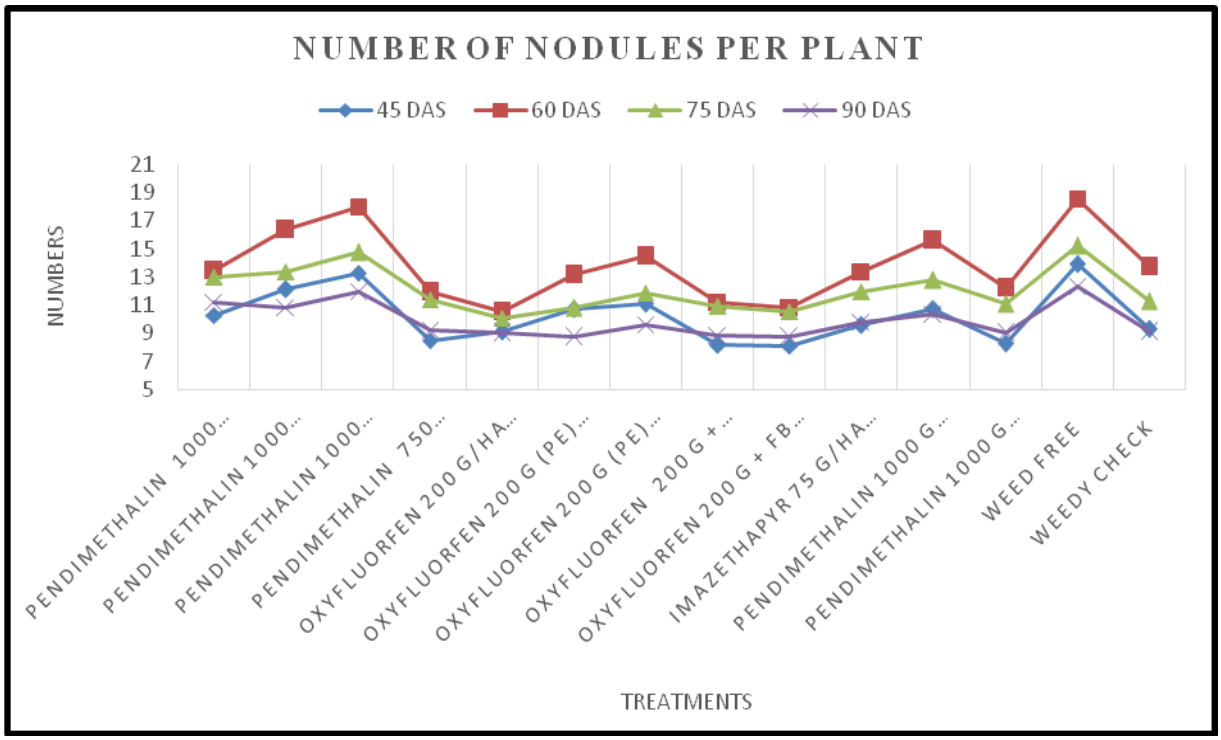


Fig.2 Effect of weed control treatments on N, P and K uptake (kgha^{-1}) by crop

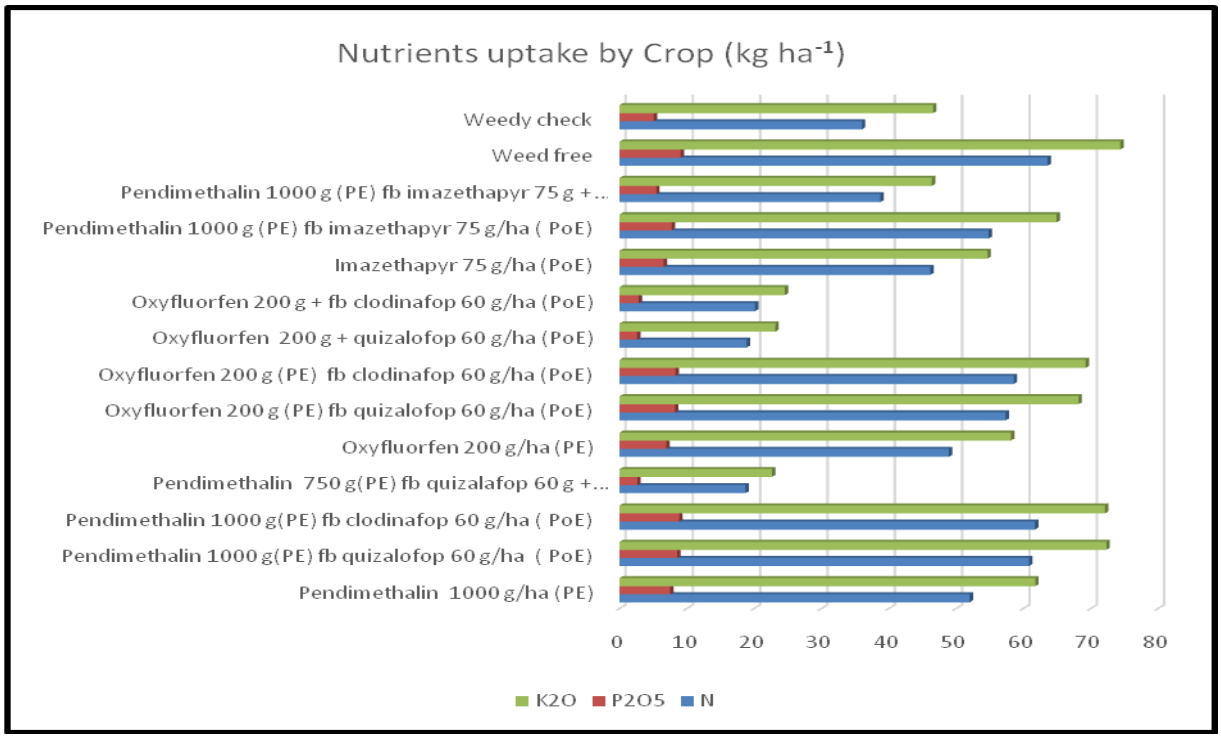
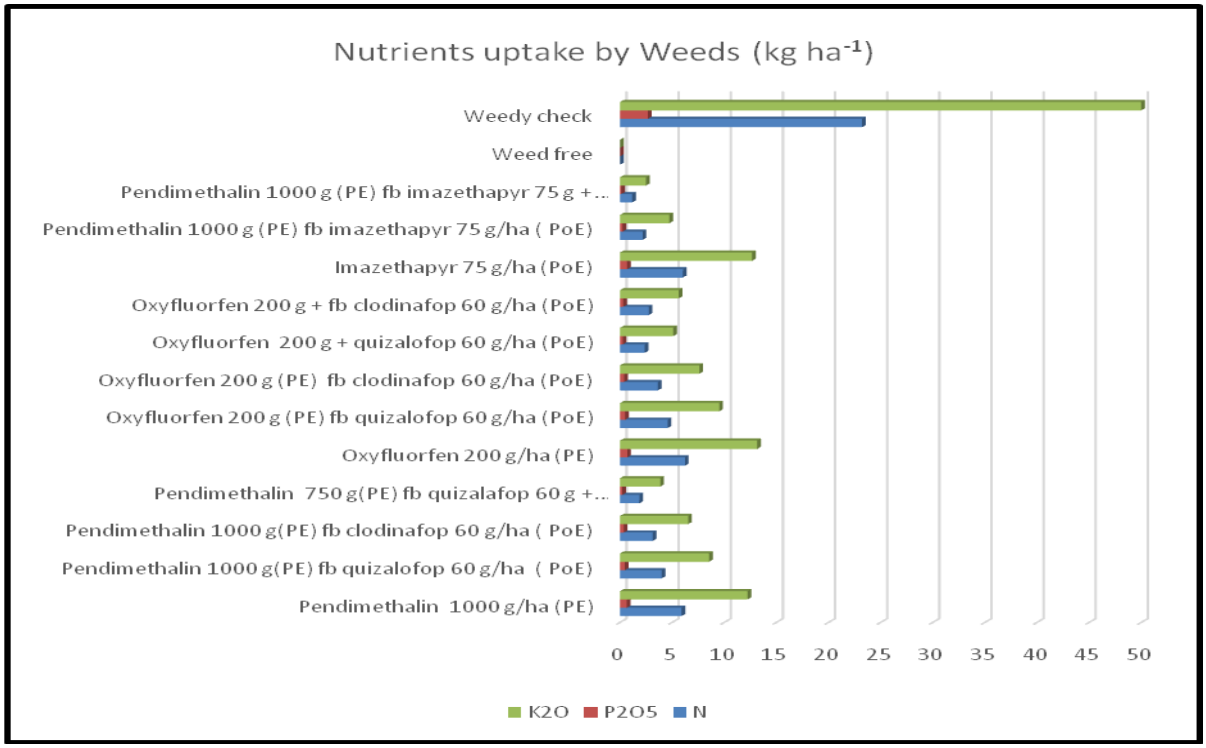


Fig.3 Effect of weed control treatments on N, P and K uptake (kgha^{-1}) by weeds



PE - pre-emergence, PoE – post emergence, fb – fallowed by

Table.1 Effect of weed control treatments on yield attributes, yield, and Economics of different treatments of chickpea

Treatments	Dry matter at harvest stage (g m^{-2})	100-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (tha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Pendimethalin 1000 g/ha (PE)	14.28	13.56	1.40	2.45	22461.95	64775.00	42313.05	1.88
Pendimethalin 1000 g(PE) *fb* quizalofop 60 g/ha (PoE)	16.68	13.99	1.62	2.86	24561.95	75010.00	50448.05	2.05
Pendimethalin 1000 g (PE) *fb* clodinafop 60 g/ha (PoE)	17.78	14.13	1.66	2.86	23889.95	77478.00	53588.05	2.24
Pendimethalin 750 g (PE) *fb* quizalafop 60 g + oxyfluorfen 200 g/ha (PoE)	12.25	12.48	0.47	0.94	26299.95	22417.00	-3882.95	-0.14
Oxyfluorfen 200 g/ha (PE)	12.45	13.59	1.32	2.30	23074.95	61067.50	37992.55	1.64
Oxyfluorfen 200 g (PE) *fb* quizalofop 60 g/ha(PoE)	14.81	13.67	1.54	2.69	25174.95	71232.50	46057.55	1.82
Oxyfluorfen 200 g (PE) *fb* clodinafop 60 g/ha(PoE)	15.30	13.98	1.58	2.71	24502.95	72885.00	48382.05	1.97
Oxyfluorfen 200 g + quizalofop 60 g/ha (PoE)	12.55	12.56	0.48	0.96	25174.95	22767.00	-2407.95	-0.09
Oxyfluorfen 200 g + *fb* clodinafop 60 g/ha (PoE)	12.85	12.89	0.52	1.00	24502.95	24507.00	4.05	0.00
Imazethapyr 75 g/ha (PoE)	14.22	13.66	1.25	2.16	21707.95	57567.00	35859.05	1.65
Pendimethalin 1000 g (PE) *fb* imazethapyr 75 g/ha (PoE)	15.40	13.89	1.47	2.55	23096.95	67932.00	44835.05	1.94
Pendimethalin 1000 g (PE) *fb* imazethapyr 75 g + quizalofop 60 g/ha (PoE)	13.86	13.10	1.03	1.86	25196.95	47814.50	22617.55	0.89
Weed free	18.33	14.27	1.72	2.93	30072.90	79062.00	48989.10	1.62
Weedy check	13.56	12.45	0.92	1.80	21072.95	43121.00	22048.05	1.04
CD (p= 0.05)	2.36	NS	0.21	0.33	-	-	-	-

Combination of the treatment pendimethalin 1000 g (PE) *fb* clodinafop 60 g ha^{-1} (PoE) showed effective control of grassy as well as BLWs. However, in case of single herbicide *e.g.* pendimethalin or oxyfluorfen controlled both type of weed very effectively at early stage but weeds which emerged at later stages could compete with the crop and ultimately declined the crop dry weight and yield levels. There was no any significant difference of 100-seed weight (g) at harvest stage of chickpea this was might have suppressed less weeds during the critical period of crop weed competition and favoured better utilization of available resources, *viz*. nutrient, light, water and space. These results are in agreement with the findings of (Dungerwal *et al.,* 2002).

Effect of weed control measures on yields

As per the data shown in table 1 we clearly told that different weed control treatments influenced significantly the yields (grain and stover) of chickpea. Use of chemicals in field to control weeds can also affect metabolic activity of plants by its phytotoxic effect and thus, reduce the yield of crop.

Maximum reduction in seed and straw yield were recorded in pre-emergence application of pendimethalin 750g ha^{-1} *fb*combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200gha^{-1} (PoE) (0.47 and 0.94tha^{-1}) at 35 DAS over weedy check (0.92 and 1.80tha^{-1}) and significantly at par with post emergence application of oxyfluorfen 200g + quizalofop-ethyl 60g ha^{-1} (0.48 and 0.96tha^{-1}) at 35 DAS and post-emergence application of oxyfluorfen 200g + clodinafop 60g ha^{-1} (PoE) (0.52 and 1.00tha^{-1}), this is might be due to less reduction of weeds from field and phytotoxic effect of herbicides on crop plants. Pendimethalin as pre-emergence followed by mix post-emergence of quizalofop-ethyl 60g + oxyfluorfen were less effective and hindered during critical period of growth. The grain yield is the fraction of the total biomass (total dry matter accumulation) that gets available in the form of economic yield (grain yield).Grain yield is the ultimate result of the bio-physiological processes and source-sink relationship.

The grain yield is contributed by different yield attributes *e.g.* number of pods $plant^{-1}$, number of grains pod^{-1}, weight of grains pod^{-1} and 100-grain weight etc**.** As far as the stover yield was concerned, it is the resultant of growth attributes *e.g.* plant population, plant height, dry matter accumulation and leaf area index etc. These attributes directly influenced by the crop-weed competition phenomena. The treatments, in which weed control was effective, ultimately provided better environment to crop for their growth resulted, better yields of stover as well as grain. These results are in the confirming with the work of Singh *et al.,* (2003) and Ratnam *et al.,* (2011).

Effect of weed control measures on economics of different treatments

Maximum cost of cultivation incurred in treatment weed free (₹ 30072.90/ha) by registering cost of cultivation₹ 26299.95/ha in pre-emergence of pendimethalin 750g followed by combined post-emergence application of quizalafop 60g + oxyfluorfen 200gha^{-1} at 35 DAS found to be the next best treatment (Table 1) maximum gross monetary returns (₹ 79062.00 ha^{-1}) was recorded in weed free by registering gross monetary returns ₹ 77478.00ha^{-1} in pre-emergence of pendimethalin 1000 g followed by post-emergence application of clodinafop 60gha^{-1} found to be the next best treatment. Maximum net monetary returns (₹ 53588.05 ha^{-1}) and B:C ratio (2.24) were recorded in pre-emergence application of pendimethalin 1000g (PE) *fb* post emergence application of clodinafop 60gha^{-1} at 35 DAS by registering net monetary returns ₹ 50448.05 ha^{-1} and

B:C ratio (2.05)in pre-emergence application of pendimethalin 1000 g *fb*by post emergence application of quizalofop-ethyl 60 gha^{-1}at 35 DAS, found to be the next best treatment and pre-emergence application of Pendimethalin 750 g followed by combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200gha^{-1}at 35 DAS and post emergence combined application of oxyfluorfen 200g + quizalofop-ethyl 60gha^{-1} at 35 DAS, the net monetary returns and B: C ratio were in negative because of high cost of cultivation (Pedde *et al.,* 2013). These above results are in the conformity with the work of Meena *et al.,* (2011) and Ratnam *et al.,* (2011).

In conclusion, on the basis of one year experiment it may be concluded that pre-emergence application of pendimethalin 1000 g ha^{-1} along with post-emergence application of either clodinafop propargyl 60 g ha^{-1} or quizalofop ethyl 60 g ha^{-1} proved superior over rest of the treatments with respect to weed control efficiency, grain yield and economics of chickpea followed by oxyfluorfen 200 g ha^{-1} as PE along with post-emergence application of clodinafop propargyl or quizalofop ethyl 60 g ha^{-1} each. However, post-emergence application of tank mixed herbicides caused the phytotoxicity to the chickpea. Effective control of weeds provide better results of crop by providing suitable environment for the growth and development of crop as well as increase input use efficiency.

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