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EFFICACY OF IMAZETHAPYR AND QUIZALOFOP-ETHYL HERBICIDES ON GROWTH AND YIELD OF CHICKPEA

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ABSTRACT
A field experiment was conducted during *rabi* 2009-10- and 2010-11 to study the response of post–emergence herbicides on growth and yield of chickpea grown in clayey soil. Among herbicides highest yield and yield attributes, viz. branches/plant, pods/plant, seed weight/plant and 100-seed weight were recorded with application of imazethapyr and quizalofop-ethyl @ 75 g/ha at 25 and 35 DAS, respectively, over weedy check. However, application of higher dose of imazethapyr @ 100 g/ha at 25 and 35 DAS significantly reduced the plant height (54.28), branches/plant (21.61), pods/plant (48), seed weight/plant (16.3) and root nodules (8.5) over lower dose of herbicides (50 g/ha), on the contrary 100-seed weight (38.946) increased over application of reduced doses. The post-emergence application of imazethapyr and quizalofop-ethyl @ 50 g/ha at 25 and 35 DAS was inefficient in effective control of weeds but at higher rate of application 75 and 100 g/ha was effective but phytotoxic on chickpea. Among the herbicides imazethapyr and quizalofop-ethyl at each dose rates decreased the grain yield, however, the intensity was more at higher rate of application *i.e.* 100 g/ha. It has been observed that imazethapyr and quizalofop-ethyl were injurious to the chickpea and injury increased with increase in the concentration of both these herbicides. Toxicity was more with imazethapyr as compared to quizalofop-ethyl at all rates of application. Chickpea injury was minimal at 35 days after application at all rates, which was insignificant with lower dose of 50 g/ha, however, which was inefficient for effective weed control. The results implied that a higher concentration of imazethapyr resulted in a decline in growth, yield attributes and yield of chickpea. There is need to change in herbicide selection or application method in order to have better weed control

INTRODUCTION

Chickpea, however, is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stages of crop growth (30-45 DAS). In addition to slow initial crop growth, wider crop spacing also facilitates crop-weed competition which poses a serious limitation in *kabuli* chickpea production and thus, estimated seed yield loss may likely to go to the extent of 88 per cent (Bhalla *et al*. 1998). The contamination of produce with weed seeds reduces the crop quality. Excessive weed competition may adversely affect seed size which is an important quality parameter in *kabuli* chickpea or macrocarpa type chickpea. The problem of weeds in chickpea is so severe due to lack of suitable weed control measures. Weeds emerge with the winter sown crop and create sever competition unless controlled timely and effectively. Current chickpea weed control strategies include crop rotations, mechanical practices, hand weeding and mostly application of pre emergence herbicides usually farmers go for manual weeding under such situation. However, availability of labour and cost involved make them to seek for other cheaper alternatives for weed control. The use of post emergence herbicides for season long weed control is thus, preferred over early use of herbicides as pre-plant incorporation (fluchloralin and trifluralin) and pre-mergence (pendimethalin) as the latter control weeds only during initial crop growth (up
to 30 DAS). Hence, an integration of both pre-emergence herbicides along with one manual weeding is needed under a season long weed management strategy. There is, therefore, an urgent need to move from the costly manual-mechanical weed control to chemical weed control for winter sowing. There is also a possibility that use of single post emergence herbicides may replace the above and raise the income of both farmers and farms. The imidazolinone class of herbicides provides a broad spectrum of weed control activity (Kantar *et al*. 1999), flexibility in timing of application, low usage rates and low mammalian toxicity (Tan *et al*. 2005). Imazethapyr is an imidazolinone herbicides, applied as pre-plant incorporated, pre-emergence and early-post emergence for control of annual grass, broad-leaf weeds and perennial sedges in chickpea and other legume fields. Quizalofop-ethyl is a herbicide which is selective against perennial and annual grass weeds in many crops. Since work on post emergence herbicides especially in chickpea is meager, an attempt has been made to evaluate the efficacy of post emergence herbicides for effective control of weeds in chickpea. The objectives of this experiments were to 1) evaluate the efficacy of post emergence herbicides viz., imazethapyr and quizalofop-ethyl, (2) evaluate crop safety of these herbicide in chickpea, and (3) evaluate post emergence herbicides for potential use in chickpea as there are no herbicides available for post emergence use.

MATERIALS AND METHODS

A field experiment to study the effect of post emergence herbicides viz. Imazethapyr and Quizalofop-ethyl on growth and yield of *kabuli* chickpea cultivar KAK-2 was carried out at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the *rabi* season 2009-10 and 2010-11. The soil of experimental site is clayey with pH 8.17, having available nitrogen 230 kg/ha, available phosphorous 19.15 kg/ha, available potassium 303 kg/ha and organic carbon 4.0 g/kg. The experiment was laid out in randomized complete block design having three replications (Gomez and Gomez 1984). The treatment comprised of weedy check, hand weeding twice at 20 and 35 DAS and three level each of imazethapyr and quizalofop-ethyl (50, 75, 100 g/ha). Herbicides application was done using a Knapsack sprayer equipped with a Flat-fan nozzle; the phytotoxicity scoring was taken as per the method suggested by Rao (1988). Chickpea seed were treated with carrier based *Rhizobium* and PSB, each at the rate of 2.5g per kg seed and mixed well to ensure the inoculums to stick on to the surface of the seeds, thereafter, the treated seeds were dried in shade for an hour and used for sowing (Anonymous, 2012). The N, P and K through urea, diammonium phosphate and muriate of potash were applied as basal at sowing. Two protective irrigations at branching and pod filling stage were given excluding pre-sowing irrigation for establishment of optimum plant stand. The crop was shown on 14 October 2009 and 26 October 2010 and was harvested on 6 and 13 February 2010 and 2011, respectively. The required plant population (45 cm row to row and 10 cm plant to plant) was maintained by thinning plants after three weeks of sowing. The crop was raised under irrigated condition with recommended package of practices for the zone (Anonymous, 2012). The total rainfall received during the crop growth was 148.4 and 40.5 mm in 7 and 2 rainy days during 2009-10, 2010-11, respectively.

RESULTS AND DISCUSSION

Weed flora

The weed flora in the experimental field consisted of grasses like *Echinochloa glabrescens*, *Bracharia* sp.; sedges like *Cyperus rotundus* and broad-leaved weeds like *Parthenium hysterophorus, Physalis minima, Digeria arvensis, Euphorbia hirta, Convolvulus arvensis*, *Phyllanthus niruri, Portulaca oleracea, Abutilon indicum, Cyanotis axillaris* etc. However, sedges like *Cyperus rotundus* and broad-leaved weed like *Parthenium hysterophorus* and *Convolvulus arvensis* dominated over other weeds in the chickpea field and *Portulaca oleracea, Abutilon indicum* and *Phyllanthus niruri* were not effectively controlled by any of the herbicides, however, *Convolvulus arvensis* could not controlled as it was emerged largely late in the crop season escapes from the herbicides application. The weed flora was more pronounce during first year of investigation due to enough soil moisture owing to post-monsoon rain.

The result revealed that among herbicides and cultural methods of weed control, application of imazethapyr (IM) @ 100 g/ha at 25 and 35 DAS followed by quizalofop-ethyl (QE) @ 100 g/ha at 25 and 35 DAS recorded lowest dry weight of weeds at all the growth stages followed by application of their respective lower doses (Table 2). However, imazethapyr was effective against annual broadleaf weeds like *Parthenium hysterophorus, Physalis minima, Digeria arvensis, Euphorbia hirta, Cyanotis axillaris* and grass weeds like *Bracharia* sp. *Echinochloa glabrescens,* perennial sedge like *Cyperus rotundus*. In case of perennial sedges control was most effective when imazethapyr was applied at 25 DAS compared to at 35 DAS where application of imazethapyr inhibits growth or part of the weed found chlorotic. Richburg *et al*. (1996) reported that imazethapyr controlled *Cyperus rotundus* more effectively when applied to weeds 5 to 20 cm tall compared with weeds 30 cm tall. Application of quizalofop-ethyl was effective for the plots where only grassy weeds were dominated as against imazethapyr which was effective against annual broadleaf weeds, grassy weeds and perennial sedges.

Effect on crop

The highest yield attributes, viz. branches/plant, pods/plant, seed weight/plant and 100-seed weight were recorded with the application of imazthapyr and quizalofop-ehtyl @ 75 g/ha at 25 and 35 DAS, respectively, over other herbicides treatments. However, application of higher dose of same herbicides reduced the plant height, branches/plant, pods/plant, seed weight/plant and root nodules over lower doses of herbicides, on the contrary 100-seed weight increased over application of reduced doses (Table 1). The minimum values of plant height at 60 DAS were recorded only under post emergence application of quizalofop ethyl by Kachhadiya *et al*. (2009). Nevertheless due to lowest dry matter of weeds in higher dose applied plot *i.e.*100 g/ha significant reduction in ancillary parameters was noticed due to crop phytotoxicity. The hand weeding twice produced significantly maximum chickpea yield (2494 kg/ha) over remaining treatments excepting imazethapyr @ 100 g/ha (2154 kg/ha). Among the herbicides imazethapyr @ 100 g/ha at 25 and 35 DAS and 75 g/ha at 25 DAS, recorded higher grain yield closely followed by quizalofop-ethyl @ 75 g/ha at 25 DAS over application of their lower dose *i.e.* 50 g/ha, further seed yield declined consistently with increase in herbicides doses.

While comparing the toxicity of all dose rates of each herbicide on grain yield, the toxicity increased in the following order: QE @ 100 /ha at 35 DAS > QE @ 100g/ha at 25 DAS >IM @ 100 g/ha at 35 DAS > IM @ 100 g/ha at 25 DAS. Conversely, weedy check and HW showed normal growth without injury which is on par with QE @ 50 g/ha at 25 and 35 DAS, IM @ 50 g/ha at 25 and 35 DAS. The results pertaining to phytotoxicity scoring (Table 1) ranged from no visible injury to slight stunting injury or crop yellowing i.e. discoloration, but no plants died from the treatment. In 2009-10 crop was subjected to rainfall events hence, crop growth was low and the phytotoxicity was more influenced the experimental results largely. Similar results were reported by Drew *et al*. (2007). Crop yellowing following some herbicide applications was more likely due to a physiological stress induced by the herbicide treatments, rather than low plant N. The applied herbicides are known to accumulate in meristematic regions of a plant, consequently affecting growth within a few days and causing chlorosis and discoloration of young tissues within 1–3 weeks of application

Table 1: Yield, ancillary parameters and phytotoxicity scoring of chickpea as influenced by different treatments

Treatment symbol	Treatment	Yield (kg/ha)		Phyto toxicity scoring at 40 DAS	No of root nodule	Fresh weight of nodule (mg/plant)	Dry weight of nodule (mg/plant)	Plant height (cm)	Branches/ plant	Pods/ plant	Seed weight /plant	100-seed weight(g)
		2009-10	2010-11									
T1	Weedy check	1366	1977	00	17.3	178	65	63.63	21.13	44	12.0	37.324
T2	HW twice at 25 & 35 DAS	2573	2815	00	18.7	175	68	59.53	25.60	57	20.5	40.515
T3	Quizalofop-ethyl @ 50 g/ha at 25 DAS	1750	2241	00	15.8	162	48	61.29	26.00	48	17.0	39.276
T4	Quizalofop-ethyl @ 50 g/ha at 35 DAS	1802	2194	00	20.4	166	53	60.23	24.87	47	16.7	37.641
T5	Quizalofop-ethyl @ 75 g/ha at 25 DAS	1796	2361	0.5	14.0	153	40	59.87	25.07	55	17.3	38.922
T6	Quizalofop-ethyl @ 75 g/ha at 35 DAS	1669	2264	0.5	18.0	158	43	58.73	23.03	53	18.5	38.693
T7	Quizalofop-ethyl @ 100g/ha at 25DAS	1591	2227	1.0	6.6	65	33	59.20	22.33	50	17.7	39.454
T8	Quizalofop-ethyl @ 100g/ha at 35DAS	1546	2162	1.0	13.7	80	40	59.07	21.14	47	17.0	39.100
T9	Imazethapyr @ 50 g/ha at 25 DAS	1638	2257	00	15.0	126	33	58.40	24.90	48	16.8	38.734
T10	Imazethapyr @ 50 g/ha at 35 DAS	1548	2085	00	19.6	139	48	55.47	24.40	45	15.9	38.650
T11	Imazethapyr @ 75 g/ha at 25 DAS	1718	2278	0.5	13.7	75	25	57.50	25.54	51	17.6	38.811
T12	Imazethapyr @ 75 g/ha at 35 DAS	1747	2271	0.5	18.7	102	40	54.54	25.22	48	16.7	38.730
T13	Imazethapyr @ 100 g/ha at 25 DAS	1944	2349	1.0	5.0	13.5	4.8	54.74	22.40	50	16.6	39.143
T14	Imazethapyr @ 100 g/ha at 35 DAS	2077	2247	1.0	12.0	47	14	53.82	20.83	47	16.0	38.750
	CD 5%	160	156	—	4.14	0.01	0.01	6.73	3.25	2.9	2.84	NS

Table 2: Dry weight of weeds and grain yield of chickpea at harvest as influenced by different treatments

Treatment symbol	Treatment	Dry weight of weeds (g/m2)	Weed control efficiency (%)
T1	Weedy check	132.24	98.79
T2	HW twice at 25 DAS & 35 DAS	1.60	0.00
T3	Quizalofop-ethyl @ 50 g/ha at 25 DAS	11.55	86.15
T4	Quizalofop-ethyl @ 50 g/ha at 35 DAS	10.57	84.86
T5	Quizalofop-ethyl @ 75 g/ha at 25 DAS	10.50	84.76
T6	Quizalofop-ethyl @ 75 g/ha at 35 DAS	10.56	84.85
T7	Quizalofop-ethyl @ 100g/ha at 25 DAS	10.43	84.66
T8	Quizalofop-ethyl @ 100g/ha at 35 DAS	10.19	84.30
T9	Imazethapyr @ 50 g/ha at 25 DAS	10.35	84.54
T10	Imazethapyr @ 50 g/ha at 35DAS	10.26	84.41
T11	Imazethapyr @ 75 g/ha at 25DAS	10.27	84.42
T12	Imazethapyr @ 75 g/ha at 35DAS	10.18	84.28
T13	Imazethapyr @ 100 g/ha at 25 DAS	10.18	84.28
T14	Imazethapyr @ 100 g/ha at 35 DAS	10.17	84.27
	CD 5%	0.03	—

in susceptible species (Cobb, 1992; Herbicide Handbook 2002). It has been observed that imazethapyr and quizalofop-ethyl, were injurious to the chickpea and injury increased with increase in concentration of both these herbicides (Table 1). Perusal of the literature showed significant adverse effects on plant vitality in chickpea treated with two different herbicides (Saghir Khan et al. 2006). These results are similar to those obtained by Aamil *et al*. (2004), Khan *et al*. (2006) and Hoseiny-Rada and Shobha Jagannath (2011).

Nodulation

The rate of nodulation at 45 DAS indicated an adverse effect of herbicides tested and therefore, the number of nodules on chickpea plants differed considerably (Table 1). Generally, all dosages of each herbicide except imazethapyr and quizalofop-ethyl @ 50g/ha, respectively, reduced the number, fresh and dry weight of nodules formed per plant relative to weedy check and HW. It has been reported that an increase in the concentration of imazethapyr and quizalofop-ethyl substantially reduced the fresh and dry weight of nodules. Among the herbicides and dosage, a maximum reduction of 75.49% and 67.65% in number of nodules formed per plant

was obtained with imazethapyr and quizalofop-ehtyl @ 100g/ha at 25 DAS, respectively, compared to HW. The decrease in nodulation was accompanied by reduction in dry mass of nodules at 45 DAS of plant growth in all treatments. Therefore it is possible that an herbicide, which induces reduction in nodules formed per plant may do this by restricting root growth and hence the number of root sites available for infection (Khan *et al*. 2006). In this study, number of nodules formed per plant was reduced following herbicides applications. The observed reduction in nodulation was thought to be a function of reduced root (Kumar *et al*. 1981). Thus herbicides whose mechanism of action is thought the inhibition of amino acids biosynthesis have different effects on *Rhizobium* (Eberbach and Douglas, 1989). These results suggest that herbicides may have affected some functional aspects of the rhizobial cells that subsequently reduced its ability to nodulate the chickpea roots. The result are corroborate with the findings of Drew *et al*. (2007) and Hoseiny-Rada and Shobha Jagannath (2011). It can be concluded that at higher concentration, imazethapyr and quizalofop-ethyl affect growth and yield of chickpea cv KAK-2 and lower concentrations were inefficient for effective weed control. The results obtained from the current study indicated that there is need to change in herbicide selection or application method in order to have better weed control particularly perennial weeds like *Cyperus rotundus* and *Convolvulus arvensis* without any phytotoxicity on chickpea.

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