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Effect of Propaquizafop on Weed Count, Yield Attributes and Yield of Soybean under Mid Hill Conditions of Himachal Pradesh, India

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A B S T R A C T

Field experiment was conducted to find out the effectiveness of eleven weed control treatments including weedy check in soybean. Propaquizafop 50g + imazethapyr 100 g/ha on 20 DAS was as effective as hand weeding twice in reducing the population of *E. colona*, *Commelina banghalensis*, *Cyperus iria*, *Ageratum conyzoides* and *Polygonum alatum*. Propaquizafop alone was not effective against *A. conyzoides* and *P. alatum*. Application of propaquizafop 75 g/ha on 15 or 25 DAS significantly enhanced the number of branches per plant, pods/plant, 1000-seed weight and seed yield of soybean. Combined tank-mix application of propaquizafop + imazethapyr, propaquizafop + chlorimuron ethyl and quizalofop ethyl + chlorimuron ethyl had more branches/plant, seeds/pod, 1000-seed weight and seed yield than other chemical treatments. These combinations were comparable to hand weeding in influencing yield attributes and seed yield of soybean.

Introduction

Soybean (*Glycine max*. L. Merrill.) grown in rainy season faces severe weed competition. It has a good suppressing ability against weeds appearing late in the season. However, the crop suffers severely due to early competitive stress of grasses, sedges and broad-leaved weeds. The weeds cause yield reductions to the extent of 20 to 77% (Tiwari and Kurchania, 1990; Kurchania *et al.*, 2001) depending upon the nature, intensity and duration of infestation. Non-adoption of the proper weed control is the major reason for its low productivity in Himachal Pradesh. Weeds compete with crop in initial stages for limited essential resources and seriously depress the crop growth and development (Singh *et al.*, 1984). Weeds increase cost of cultivation and deplete resource base (Buriro *et al.*, 2003). The effective and economical weed control may not be possible through manual or mechanical means due to heavy and continuous rainfall in *kharif*. Hence, use of herbicides offers an alternative to manage weeds in this situation. The herbicides presently available are either pre-emergence or pre-plant incorporated and have a narrow spectrum of weed control. Further, if farmers skip application of these pre-emergence or pre-plant incorporated herbicides due to one or the other reason, require an alternative post

emergent herbicide application for managing weeds in soybean. Therefore, there is a need of new post-emergent herbicide which must have broader spectrum of activity. Keeping these facts in view, the present investigation was carried out to evaluate propaquizafop for an effective weed control in soybean.

Materials and Methods

The field experiment with eleven treatments constituting of propaquizafop 60 and 75 g/ha on 15 and 25 days after sowing (DAS), propaquizafop 50 g/ha tank-mixed with imazethapyr 100g and chlorimuron ethyl 4 g/ha on 20 DAS, quizalofop ethyl 60g + chlorimuron ethyl 4 g/ha on 15 DAS, pre-emergence pendimethalin 1500 g/ha, hand weeding and mechanical weeding (20 and 40 DAS) and weedy check was conducted at Palampur during the rainy season of 2016.

The experiment was laid out in Randomized Block Design with three replications. The soil of the experimental site was silty clay loam in texture, acidic (pH 5.6) in reaction, low in available N (128 kg ha-1) and medium in available P (13.9 kg ha-1) and K (155 kg/ha). The crop was fertilized with 20 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha through urea, single super phosphate and muriate of potash, respectively. Full dose of nitrogen, phosphorus, potassium through urea, single super phosphate and muriate of potash was applied at the time of sowing (as per the recommended package of practices).

The herbicides were applied using Knapsack sprayer fitted with flat fan nozzle at a spray volume of 600 litres of water per ha. The data on weed population were recorded at 30, 60, 90 and at harvest but described only at their maximum dry weight stage *i.e.* at 60 DAS. Observations on yield attributing and yield were recorded at harvest. The experimental data on weed count, yield and yield parameters were subjected to statistical analysis as per Gomez and Gomez (1984) and were tested at 5 per cent level of significance to interpret the treatment differences. Rest of the package of practices was as per the recommendations of the university.

Results and Discussion

Weed count

Major weed flora associated with the soybean crop was constituted of *Echinochloa colona* (22.3%), *Commelina benghalensis* (19.2%), *Cyperus iria* (28.2%), *Ageratum conyzoides* (10.2%) and *Polygonum alatum* (11.8%). The other minor weeds *viz*. *Panicum dichotomiflorum*, *Euphorbia* sp and *Bidens pilosa* as a whole constituted 8.4% of the total weed flora.

All weed control treatments were significantly superior to weedy check in reducing the population of *E. colona*, *C. benghalensis* and *C. Iria.* Propaquizafop 50g + imazethapyr 100 g/ha on 20 DAS was as effective as hand weeding twice in reducing the population of *E. colona*. The effective control of *E. colona* with hand weeding has also reported by Rao and Rao (2003). All weed control treatments except pre-emergence application of pendimethalin at 1500 g/ha were significantly superior to weedy check in reducing the count of *C. benghalensis.* Hand weeding twice remaining at par with propaquizafop 50g + imazethapyr 100 g/ha on 20 DAS resulted in significantly lower population of *C. benghalensis*. Tank-mix application of propaquizafop 50g + imazethapyr 100 g/ha, propaquizafop 50g + chlorimuron-ethyl 4 g/ha, quizalofop-ethyl 60g + chlorimuron-ethyl 4 g/ha and hand weeding (20 and 40 DAS) gave better control of *C. iria* than other treatments. Panda *et al.*, (2015) also reported effective control of *C. iria* with imazethapyr in soybean. Hand weeding (20 and 40 DAS)

gave lower count of *A. conyzoides* followed by tank mix application of propaquizafop 50g + imazethapyr at 100 g/ha and propaquizafop 50g + chlorimuron-ethyl 4 g/ha (Table 1). However, sole application of propaquizafop at different times and doses and pre-emergence application of pendimethalin could not significantly reduce the population of *Ageratum*. Propaquizafop at 50 g/ha in combination with imazethapyr 100 g/ha resulted in complete elimination of *P. alatum.* However, post emergence application of propaquizafop could not significantly reduce its count over weedy check.

Yield attributes and yield

Phytotoxicity was not observed in pre- and post-emergence herbicidal treatments (data not shown). The results are in conformity with Aggarwal *et al.,* (2014) and Chandrakar *et al.,* (2014). The data on effect of different treatments on yield attributes and yield of soybean have been presented in Table 2. Number of plants per square metre was not significantly affected due to weed control treatments.

All weed control treatments increased number of branches/plant significantly over weedy check. Among all the treatments, the minimum number of pods per plant was recorded under weedy check (7.3), which was increased significantly when weed control measures were adopted. Application of propaquizafop 75 g/ha on 15 or 25 DAS significantly enhanced the number of branches per plant than the other propaquizafop dose in soybean. But combined tank-mix application of propaquizafop + imazethapyr had more number of branches per plant than other treatments. However, none of the herbicidal treatments surpassed hand weeding (20 and 40 DAS) which proved significantly superior over other treatments except propaquizafop 50g + imazethapyr 100 g/ha, quizalofop-ethyl 60g + chlorimuron-ethyl 4 g/ha and propaquizafop 50g + chlorimuron-ethyl 4 g/ha on 20 DAS. Pendimethalin 1000 g/ha was as similar as propaquizafop 75 g/ha on 25 DAS.

Weed control treatments significantly affected numbers of pods/plant (Table 2). Post-emergence application of propaquizafop 75 g/ha on 15 and 25 DAS significantly enhanced the number of pods/plant than other sole treatments of propaquizafop 60 g/ha. Hand weeding (20 and 40 DAS) significantly increased the number of pods per plant which was at par to tank mixtures of propaquizafop 50g + imazethapyr 100 g/ha and propaquizafop 50 + chlorimuron-ethyl 4 g/ha applied on 20 DAS. Weed control treatments had no significant effect on the number of seeds per pod as might be governed by genetic factor. It was evident from data (Table 2) that weed control treatments significantly influenced 1000-seed weight. All weed control treatments significantly increased 1000-seed weight over the weedy check. Application of propaquizafop 75 g/ha on 15 and 25 DAS significantly enhanced 1000-seed weight than the other sole treatments of propaquizafop in soybean. But, combined tank-mix application of propaquizafop 50 + imazethapyr 100 g/ha had more 1000-seed weight than other chemical treatments. However, none of the herbicidal treatments surpassed hand weeding (20 and 40 DAS) which proved significantly superior over other treatments except propaquizafop 50 + imazethapyr 100 g/ha on 20 DAS. Improvement in yield contributing characters due to these treatments may be attributed to significantly lower weed density which created favourable condition for better plant growth and development in the crop. These results are in conformity with Aggarwal *et al.,* (2014) and Mansoori *et al.,* (2015).

The seed yield under weedy check was 10.23 q/ha, which increased significantly when weed control measures were adopted.

Table.1 Effect of treatments on species-wise (No./m^2) weed density at maximum population stage i.e. 60 DAS

Treatment	Dose (g/ha)	TOA (DAS)	*E. colona*	*C. benghalensis*	*C. iria*	*A. conyzoides*	*P. alatum*
Propaquizafop	60	15	6.4 (40.3)	6.0 (35.4)	10.0 (100.4)	6.1 (36.3)	6.5 (41.4)
Propaquizafop	60	25	6.3 (39.5)	5.7 (32.0)	10.0 (99.3)	6.0 (35.1)	6.4 (40.0)
Propaquizafop	75	15	5.9 (34.7)	5.2 (26.1)	9.9 (98.5)	5.9 (34.3)	6.3 (39.1)
Propaquizafop	75	25	5.8 (33.1)	4.6 (20.7)	9.9 (97.2)	5.9 (33.9)	6.2 (38.4)
Propaquizafop+ imazethapyr	50+100	20	4.6 (20.7)	4.1 (16.0)	5.7 (32.0)	2.7 (6.8)	0.7 (0.0)
Propaquizafop+chlorimuron ethyl	50+4	20	5.7 (32.0)	5.2 (26.1)	6.5 (42.3)	3.0 (8.3)	3.8 (14.3)
Quizalofop ethyl + chlorimuron ethyl	60+4	15	5.2 (26.1)	4.4 (18.6)	6.1 (37.0)	4.1 (16.0)	4.1 (16.0)
Pendimethalin	1500	Pre-	6.5 (42.3)	7.7 (58.4)	10.1 (101.0)	5.2 26.1)	4.6 (20.7)
Hand weeding twice	-	20 and 40	4.1 (16.0)	2.9 (7.7)	4.6 (20.7)	1.8 (2.7)	2.9 (8.2)
Mechanical weeding	-	20 and 40	7.0 (48.0)	6.1 (37.0)	7.0 (48.0)	4.6 (20.7)	3.7 (13.0)
Weedy check	-	-	9.0 (80.0)	8.3 (69.1)	10.1 (101.2)	6.1 (36.7)	6.5 (42.3)
CD (P=0.05)			1.0	1.2	1.0	1.2	1.4

Data transformed to square root transformation ($\sqrt{x+0.5}$). *Value in parentheses are the means of original values. TOA= Time of application; pre-, pre-emergence

Table.2 Effect of treatments on yield attributes and yield of soybean

Treatment	Dose (g/ha)	TOA (DAS)	Plant count (No./m^2)	Branches/ plant	Pods/ plant	Seeds/ pod	1000- seed weight (g)	Seed yield (q/ha)
Propaquizafop	60	15	10.4	9.0	33.3	2.0	156.7	11.64
Propaquizafop	60	25	11.1	9.7	34.3	2.0	157.0	13.40
Propaquizafop	75	15	11.9	10.3	36.7	2.0	157.7	14.11
Propaquizafop	75	25	11.9	11.0	37.0	2.3	158.0	14.81
Propaquizafop + imazethapyr	50 + 100	20	13.3	12.3	42.7	2.4	162.0	22.22
Propaquizafop + chlorimuron ethyl	50 + 4	20	12.6	11.7	39.0	2.3	160.7	18.34
Quizalofop ethyl + chlorimuron ethyl	60 + 4	15	12.6	12.0	42.3	2.4	161.0	20.63
Pendimethalin	1500	Pre-	12.6	11.2	38.7	2.1	160.0	16.75
Hand weeding	-	20 and 40	13.3	12.7	43.7	2.5	162.7	23.63
Mechanical weeding	-	20 and 40	11.9	10.7	37.0	2.3	159.3	15.70
Weedy check	-	-	10.4	7.3	30.3	2.0	155.9	10.23
CD (P=0.05)			NS	1.8	4.5	NS	1.2	4.5

TOA: Time of application; DAS: Days after sowing

Post-emergence application of propaquizafop at 75 g/ha on 15 and 25 DAS significantly increased the seed yield than the lower dose of propaquizafop (60 g/ha) in soybean.

Combined tank-mix application of propaquizafop + imazethapyr had more seed yield than other chemical treatments. Propaquizafop 50g + imazethapyr 100 g/ha on 20 DAS and quizalofop-ethyl 60g + chlorimuron-ethyl 4 g/ha applied on 15 DAS were comparable to hand weeding in influencing seed yield of soybean.

The higher seed yield in these treatments could be attributed to improved yield contributing characters.

This improvement was due to lower weed competition, which shifted the balance in favour of crop in utilization of nutrients, moisture, light and space.

The present investigation conclusively revealed the superiority of propaquizafop 75 g/ha on 15-25 DAS for controlling grassy weeds in soybean. However, for mixed weed flora management and higher yield attributes and yield, tank mixed propaquizafop 50g + imazethapyr 100 g/ha on 20 DAS or propaquizafop 50g + chlorimuron-ethyl 4 g/ha on 20 DAS are recommended as an alternative/rotational use to quizalofop-ethyl 60g + chlorimuron-ethyl 4 g/ha applied on 15 DAS.

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