International Journal of Tropical Agriculture
Volume 40, Numbers (3-4) • 2022 : pp. 255-261
ISSN: 0254-8755

Evaluation of Ready Mix Post-emergence Herbicides for Controlling Weeds in Soybean [*Glycine max* (L.) Merrill] and Their Residual Effect on Succeeding Chickpea

Uditi Dhakad[1], Baldev Ram[2], Chaman K. Jadon[3], S.L. Yadav[4] and R.K. Yadav[5] and S.N. Meena[6]

PhD Scholar[1], College of Agriculture, Agricultural Research Station[2,3,4,5,6], Ummedganj, Kota, Agriculture University, Kota, Rajasthan, India-324001
uditi1303@gmail.com

Abstract: A field experiment was conducted during *kharif* 2021 at Research Farm of Agricultural Research Station, Kota to evaluate the bio-efficacy of newer ready mix post-emergence herbicides for weed control in soybean and to study their effect on growth, yield attributes, yields and economics and residual effect on succeeding chickpea crop. The results revealed that post-emergence ready mix herbicide fomesafen + fluazifop-p-butyl 220 g *a.i.*/ha was significantly superior in reducing grassy, broad leaved and sedges weed density, weed dry matter and N,P,K depletion by weeds and ultimately registered highest weed control efficiency (85.41, 79.97% at 30, 60 DAS) over other treatments. Significantly higher values for yield attributes and yields *viz.* seed, straw and biological yield (1760, 2364 & 4124 kg/ha, respectively) was observed by application of fomesafen + fluazifop-p-butyl 220 g *a.i.*/ha followed by propaquizafop + imazethapyr 125 g a.i./ha (1730, 2323 & 4053 kg/ha) and sodium acifluorfen + clodinafop propargyl 245 g a.i./ha (1628, 2204 & 3832 kg/ha). Maximum net return (₹55008/ha) and B:C ratio (2.30) was fetched with fomesafen + fluazifop-p-butyl 220 g *a.i.*/ha. No phytotoxicity symptoms on soybean crop and no residual effect on succeeding chickpea crop was observed due to PoE herbicides applied in preceding soybean.

Keywords: bio-efficacy, post-emergence, ready mix, residual effect

INTRODUCTION

Soybean [G*lycine max* (L.) Merrill] has emerged as a potential protein and oilseed crop in the world with wider adaptability and high yield potential in comparison to any other oilseed and pulse crop in the *kharif* season. In India, during 2020, soybean occupied an area of 11.84 mha with the production of 10.45 mt (Anonymous, 2021). Rajasthan occupied an 11.29 lakh ha area, 10.94 lakh tones production and 969 kg/ha productivity (Anonymous, 2020-21). The productivity of soybean in Rajasthan is comparatively lower than that of Madhya Pradesh (1231 kg/ha), Maharashtra (1132 kg/ha), India (1192 kg/ha) and the world (2491 kg/ha) (World market and trade USDA, 2022). Being a rainy season crop, soybean suffers severely due to crop-weed competition stress. Predominantly weeds like *Echinochloa crusgalli, Echinochloa colona, Commelina benghalensis, Panicum dichotomiflorum, Polygonum spp., Aeschynomene indica and Digitaria sanguinalis, Eleusine aegyptium and Cyperus spp.* are mainly associated with soybean crop. Weeds may cause yield reduction of about 30-80% in soybean (Gupta *et al*., 2006). There is a large variation in the nutrients loss by weeds depending upon the crop, location and degree of weed control etc. Poor control of weeds is one of reason for the lowered fertilizer use efficiency as well as productivity. Weed management in soybean

Article History: Received: 11 March 2022; Revised: 21 April 2022; Accepted: 16 June 2022

had really been a challenging factor mainly in *kharif* season due to unpredictable rains, non-workable soil conditions in rainy days and non-availability of timely labor. Weed management through herbicide mixtures provide broad spectrum weed control. Experiments related to various herbicides have been done so far but for the dynamic evaluation of bio-efficacy of recent available newer herbicides is an important concern in the soybean based cropping systems.

MATERIAL AND METHODS

A field experiment was carried out in soybean [*Glycine max* (L.) Merrill] crop during *kharif* 2021 at Agricultural Research Station, Ummedganj, Kota (Agriculture University, Kota), situated at 25°13′ N latitude, 75°25′ E longitude and at an altitude of 258 m above mean sea level. This region comes under Agro-climatic Zone V of Rajasthan i.e. Humid South Eastern Plain. Six ready mix post-emergence herbicides with two different doses *viz.* propaquizafop + imazethapyr 93.75 g *a.i.*/ha, propaquizafop + imazethapyr 125 g *a.i.*/ha, sodium acifluorfen + clodinafop propargyl 183.7 g *a.i.*/ha, sodium acifluorfen + clodinafop propargyl 245 g *a.i.*/ha, fomesafen + fluazifop-p-butyl 165 g *a.i.*/ha and fomesafen + fluazifop-p-butyl 220 g *a.i.*/ha, were evaluated for effective weed management in soybean. The experiment was laid out in randomized block design (RBD) with three replications. Soybean crop cv. JS 20-34 was sown using tractor drawn seed drill 30 cm apart of row space and at depth of 2-3 cm using a seed rate 80 kg/ha. Seed treatment was done with 1g/kg carbendazim. Urea, single super phosphate (SSP) and muriatic of potash (MOP) were used as source of nitrogen, phosphorus and potash, respectively and a uniform recommended fertilizer dose of nitrogen, phosphorus and potash (20:40:40 kg/ha) was drilled in furrow at a 8- 12 cm depth at the time of sowing. Post-emergence herbicides were applied at 16 DAS with use of 0.1 per cent non-ionic surfactant. All the herbicides were sprayed through knapsack sprayer using flat fan nozzle using 500 litre water/ha as per treatments. The weeds were counted at 30, 60 DAS and at harvest. Two spots were randomly selected using 0.5 m^2 quadrate in each plot. Grassy, broad leaved weeds and sedges were counted separately and expressed as no./m^2. The data were subjected to square root transformation $\sqrt{x+0.5}$ to normalize their distribution (Gomez and Gomez, 1984). The samples were oven dried at 70^0C for 48 hours and weighed and the dry matter was calculated and expressed as g/m^2. Weed control efficiency (WCE) was calculated at 30, 60 DAS and at harvest using the formula given by Varshney (1990); Weed Control Efficiency(%) $= \frac{DMC - DMT}{DMC} \times 100$.

Plant stand per meter row length was observed. The plant height (cm) was measured at 30, 45, 60 DAS and at harvest. Dry matter accumulation (g/plant) was recorded at 30, 45, 60 DAS and at harvest by oven drying the crop samples at 70° C. The numbers of branches arising from the nodes of stem were counted at 30, 60 DAS and at harvest. The nodules were carefully dugout from wet soil condition and then roots were washed gently and thoroughly with water in sieve and number of nodules was counted per plant. Dry weight of nodules was taken by oven drying the nodules. Pods/plant and seeds/pod were counted. 1000 seed weight (g) was taken by weighing seeds on an electrical balance. Seed, straw and biological yield (kg/ha) was calculated. After threshing and winnowing seed yield/net plot was weighed which was expressed as kg/ha. The unthreshed produce from net plot area after thorough sun drying was weighed for recording the biological yield and expressed as kg/ha. The straw yield in kg/ha was calculated by subtracting the corresponding seed yield from the biological yield. Harvest Index was computed using the formula (Donald and Hamblin, 1976);

$$\text{Harvest index (\%)} = \frac{Economic\ yield\ (kg/ha)}{Biological\ yield\ (kg/ha)} \times 100.$$

Soxhlet ether extraction method (A.O.A.C., 1965) was used to determine oil content (%) in soybean seed. Protein content (%) in seed was computed by multiplying nitrogen content (%) to the factor of 6.25 (Simson *et al*., 1965). Phytotoxicity studies on soybean done by visual scoring i.e. wilting, vein clearing, necrosis,

epinasty and hyponasty at 3, 5, 7, 10, 15, 20, 25 and 30 days after herbicide application using the standard scale (0-10). Succeeding chickpea (GNG 1958) was sown at the same site for residual studies, with seed rate of 80 kg/ha and recommended practices. To find out the most profitable treatment, economics of various treatments was worked out in terms of net return/ha and rupees per rupee invest. The economics of various treatments was worked out taking into account the existing market rate of various production factors and produce during the course of investigation. The cost of cultivation for each treatment was determined on the basis of different inputs used for raising the crop under different treatments on one hectare area basis.

RESULTS AND DISCUSSION

Effect on weed density, weed dry matter, nutrient depletion by weeds and weed control efficiency

Grassy weeds (53.1%) such as *Echinochloa colonum*, *E. crusgalli*, *Cyanodon dactylon*, *Eleusine indica*, and broadleaved weeds (46.9%) like *Celosia argentea*, *Digera arvensis*, *Commelina benghalensis* and *Trianthema portulacastrum* were the most prominent weeds in soybean crop during *kharif* season. *Cyperus rotundus* (9.4 %) was the only sedge weed found in the experimental field. All the herbicidal treatments recorded significantly lower total weed density and weed dry matter as compared to weedy check at 30, 60 DAS and at harvest. Results revealed significant reduction in weed density, weed dry matter and nutrient (N, P & K) depletion by weeds at 30, 60 DAS and at harvest was observed due to application of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha, closely followed by propaquizafop 2.5% + imazethapyr 3.75 % 125 g *a.i.*/ha and sodium aciflourfen + clodinafop-propargyl 245 g *a.i.*/ha. Among all herbicides, ready mix PoE fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha resulted in maximum weed control efficiency (85.41, 79.97 and 77.39%, respectively) at 30, 60 DAS and at harvest (Table 1). The lower doses of these herbicide mixtures were also found significantly superior to weedy check. These treatments curbed the weeds completely and provide the favorable condition for crop growth and ultimately reduced the weed density of later emergence stage and their lower weed dry matter accumulation during crop growth period resulted in to reduced nutrient depletion by weeds. Reduced nutrient uptake by weeds under the influence of different weed control measures in soybean have been also reported by Harisha *et al.* (2021). Maximum depletion of 14.69, 6.73 and 11.67 kg N, P and K/ha, respectively by weeds at harvest was reported in weedy check plot, it was significantly higher over other treatments.

Effect on soybean crop

Growth parameters

All the PoE herbicidal (RM) treatments produced significantly superior growth parameters of soybean crop at all the growth stages (at 30, 60 DAS and at harvest) as compared to weedy check (Table 2). In *kharif* season, the growth of weeds is faster than crop. Thus, in weedy condition crop plants have to compete for solar radiation in addition to nutrients (Jadon *et al.*, 2019). Thus, highest plant height of soybean was observed in weedy check at 30 DAS (23.93 cm) whereas at 60 DAS and at harvest it was observed more in the herbicide treated plots since they checked the weed population and growth. All the weed control measures increased the periodical dry matter production of crop, branches/plant, pods/plant, nodules/plant, dry weight of nodules at various growth stages (Table 2).

Yield attributes and Yields

Weed control treatments significantly improved number of pods/plant, 1000 seed weight, seed, straw and biological yield in comparison to weedy check (Table 2.2 & 2.3). The effect was more pronounced with admixture of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL, sodium acifluorfen 16.5% EC + clodinafop-propargyl 8% EC and propaquizafop 2.5% + imazethapyr 3.75%. This can be attributed to lowest infestation of weeds which caused lesser nutrient drain together with lesser degree of competition for other growth resources. These herbicides recorded higher values for pods/plant (43.7 to 58.9) and 1000 seed

weight (132.1 to 137.1 g), however no significant values were recorded for seeds/pod. The better expression of yield attributes in herbicide treated plots might be due to poor resurgence frequency and growth of weeds in these treatments. Treatments fomesafen 11.1% + fluazifop-p-butyl 11.1% SL, sodium acifluorfen 16.5% EC + clodinafop-propargyl 8% EC and propaquizafop 2.5% + imazethapyr 3.75% at both higher and lower doses were found significantly superior in enhancement of seed, straw and biological yields over weedy check, which may be due to better weed control which created favorable growth conditions such as increased nutrient availability, moisture, light and other factors to the crop plants, which ultimately resulted in better growth and higher dry matter production of plants. The highest seed (1760 kg/ha), straw (2364 kg/ha) and biological (4124 kg/ha) yield were observed with ready mix post-emergence application of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha.

Quality parameters and Nutrient uptake

Weed control treatments significantly increased protein content of seed over weedy check, but could not bring significant changes in improving the oil content of soybean. The herbicidal mixture fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha recorded maximum protein content in seed (40.76%) over rest other treatments. Ready mix application of herbicides significantly increased N, P & K uptake by crop over weedy check. Ready mix of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha recorded significantly higher total N (165.0 kg/ha), P (15.24 kg/ha) & K (86.92 kg/ha) remained statistically at par with propaquizafop 2.5% + imazethapyr 3.75 % 125 g *a.i.*/ha and sodium acifluorfen 16.5 % EC + clodinafop-propargyl 8 % EC 245 g *a.i.*/ha as compared to rest of the herbicidal treatments (Table 4).

Economics

Maximum net returns of ₹ 55008/ha with B: C ratio of 2.30 was fethched with the application of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha, closely followed by propaquizafop 2.5% + imazethapyr 3.75% 125 g *a.i.*/ha 125 g *a.i.*/ha (₹ 42043/ha & 1.59) and sodium acifluorfen 16.5% EC + clodinafop-propargyl 8% EC 245 g *a.i.*/ha (₹ 40322/ha & 1.67) which was significantly higher than lower doses and weedy check (₹ 2881/ha & 0.13). The higher B:C ratio achieved under superior treatments might be due to higher seed yield and higher returns per rupee investment. (Table 3)

Effect on soybean crop phytotoxicity

It was observed that none of the herbicide mixtures showed any phytotoxicity symptom (wilting, vein clearing, necrosis, epinasty and hyponasty). Thus, it can be inferred that tested herbicide mixtures were selective to soybean crop and can be used safely. Patel *et al.* (2021) did not observe any phytotoxicity of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha on soybean. Bagotiya *et al.* (2018) found that sodium acifluorfen + clodinafop-propargyl and propaquizafop 2.5% + imazethapyr 3.75 % 125 g *a.i.*/ha caused some yellowing of leaves and cessation of growth in soybean but crop plants recovered within 6-7 days and had no negative effect on crop yield.

Residual effect on succeeding chickpea

The herbicidal treatments applied to preceding soybean did not show any residual effect on succeeding chickpea as growth parameters, yield attributes and yield of chickpea remain same.

CONCLUSION

Based on the field experiment, it can be concluded that all post-emergence ready mix herbicide treatments resulted in broad spectrum weed control in soybean thus enhancing the crop productivity with respect to weedy check. The PoE herbicide mixture of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL 220 g *a.i.*/ha recorded lowest weed density and weed dry matter, highest weed control efficiency (85.41, 79.97 & 77.39 % at 30, 60 DAS and at harvest, respectively), lowest nutrient depletion by weeds (3.32, 1.41 & 2.51 kg NPK/ha), higher total nutrient uptake by crop (165.0, 15.24 & 86.92 kg NPK/ha), oil yield (349.1 kg/ha), protein yield (717.6 kg/ha), seed yield (1760 kg/ha), maximum net return (₹55008/ha), B:C ratio (2.30) among

Table 1: Effect of weed control measures on total weed density, weed dry matter and weed control efficiency in soybean

Treatments	*Total weeds*			*Total weed dry matter accumulation (g/plant)*			*Weed Control Efficiency %*		
	30 DAS	*60 DAS*	*Harvest*	*30 DAS*	*60 DAS*	*Harvest*	*30 DAS*	*60 DAS*	*Harvest*
Weedy check	8.15*	15.93*	14.09*	410.66	779.15	578.69	0.00	0.00	0.00
Pendi. + Imaz. 960 g/ha PE	4.21	9.46	9.81	96.35	283.35	255.59	76.47	62.29	55.31
Propaqf. + Imaz. 93.7 g/ha PoE	5.02	9.03	9.59	109.87	268.28	208.64	73.28	64.80	63.58
Propaqf. + Imaz.125 g/ha PoE	3.95	6.61	8.04	61.63	155.87	134.50	84.87	79.64	76.40
Sod. Acif. + Clodina.P.183.7 g/ha PoE	5.13	9.19	9.66	113.25	276.06	212.43	72.27	63.84	62.85
Sod. Acif. + Clodina.P.245 g/ha PoE	4.08	6.80	8.14	64.14	161.51	137.15	84.36	78.80	75.84
Fomsaf. + Fluazi.FB165 g/ha PoE	5.06	9.08	9.43	109.97	268.16	204.85	73.07	64.80	64.01
Fomsf. + Fluazi.FB 220 g/ha PoE	3.84	6.43	7.74	59.34	155.07	129.72	85.41	79.97	77.39
CD (P=0.05)	0.46	0.53	0.87	27.19	63.12	47.04	5.18	6.05	6.14

*Values are $\sqrt{x + 0.5}$ transformed

Table 2: Effect of weed control measures on plant stand, plant height and dry matter accumulation in soybean

Treatments	*Plant stand (no./ mrl)*		*Plant height (cm)*				*Dry matter accumulation (g/plant)*			
	30 DAS	*Harvest*	*30 DAS*	*45 DAS*	*60 DAS*	*Harvest*	*30 DAS*	*45 DAS*	*60 DAS*	*Harvest*
Weedy check	12.20	10.87	23.93	40.53	51.00	51.50	0.88	2.92	9.46	11.75
Pendi. + Imaz. 960 g/ha PE	11.93	11.53	21.30	30.00	42.17	46.53	1.38	4.43	13.01	17.69
Propaqf. + Imaz. 93.7 g/ha PoE	12.07	11.87	20.33	32.63	42.90	48.37	1.32	4.46	14.57	23.61
Propaqf. + Imaz.125 g/ha PoE	12.60	12.20	22.33	35.13	46.03	54.97	1.83	6.00	17.42	27.44
Sod. Acif. + Clodina.P.183.7 g/ ha PoE	12.20	11.33	20.63	32.67	43.47	47.93	1.58	4.28	14.54	23.50
Sod. Acif. + Clodina.P.245 g/ha PoE	12.33	11.80	21.97	34.50	45.87	54.37	1.80	5.94	17.27	27.28
Fomsaf. + Fluazi.FB165 g/ha PoE	12.27	11.73	21.53	32.87	44.00	48.77	1.56	4.69	14.63	24.11
Fomsf. + Fluazi.FB 220 g/ha PoE	12.13	11.80	22.77	35.53	46.20	55.80	1.87	6.04	17.51	27.72
CD (P=0.05)	NS	NS	NS	3.29	5.84	6.06	0.18	0.90	2.53	3.19

Table 3: Effect of weed control measures on yield attributes of soybean

Treatments	*Branches/plant*			*Nodules/ plant*	*Dry weight of nodules*	*Pods/ plant*	*Seeds/ pod*	*Test weight (g)*
	30 DAS	*60 DAS*	*Harvest*					
Weedy check	1.00	1.13	1.20	31.14	38.45	20.1	2.30	109.4
Pendi. + Imaz. 960 g/ha PE	1.20	1.80	2.07	44.40	56.36	40.8	2.33	132.5
Propaqf. + Imaz. 93.7 g/ha PoE	1.20	1.93	2.50	42.40	64.76	43.7	2.37	132.1
Propaqf. + Imaz.125 g/ha PoE	1.33	2.53	3.27	51.80	74.58	57.7	2.60	136.8
Sod. Acif. + Clodina.P.183.7 g/ha PoE	1.27	1.67	2.40	44.40	63.75	42.8	2.30	130.6
Sod. Acif. + Clodina.P.245 g/ha PoE	1.27	2.53	3.33	51.20	77.61	57.7	2.57	136.4
Fomsaf. + Fluazi.FB165 g/ha PoE	1.23	1.87	2.47	43.80	63.85	44.5	2.50	131.4
Fomsf. + Fluazi.FB 220 g/ha PoE	1.30	2.60	3.33	52.10	78.32	58.9	2.60	137.1
CD (P=0.05)	NS	0.45	0.46	5.15	5.69	6.77	NS	7.25

Table 4: Effect of weed control measures on total nutrient uptake, yield and economics of soybean

Treatments	*Total nutrient uptake by soybean (seed+straw)*			*Seed Yield (kg/ha)*	*Straw yield (kg/ha)*	*Net return (Rs/ha)*	*B: C ratio*
	N (kg/ha)	*P (kg/ha)*	*K (kg/ha)*				
Weedy check	56.1	5.60	32.81	626	977	6751	0.31
Pendi. + Imaz. 960 g/ha PE	100.2	9.72	54.48	1127	1527	25286	1.00
Propaqf. + Imaz. 93.7 g/ha PoE	126.6	12.16	68.68	1407	1897	37779	1.49
Propaqf. + Imaz.125 g/ha PoE	160.4	14.97	84.63	1730	2323	51243	1.94
Sod. Acif. + Clodina.P.183.7 g/ha PoE	121.0	11.55	66.19	1340	1808	36504	1.54
Sod. Acif. + Clodina.P.245 g/ha PoE	152.3	14.12	80.83	1628	2204	49051	2.04
Fomsaf. + Fluazi.FB165 g/ha PoE	127.6	12.19	69.60	1413	1905	39874	1.69
Fomsf. + Fluazi.FB 220 g/ha PoE	165.0	15.24	86.92	1760	2364	55008	2.30
CD (P=0.05)	14.6	1.34	7.76	180.7	238.2	7436	0.31

Table 5: Residual effect of weed control measures on succeeding chickpea crop

Treatments	*Plant Stand (no./mrl) at 45 DAS*	*Plant Height (cm) at 45 DAS*	*Dry matter (g/plant) at 45 DAS*	*Branches/ plant (No.)*	*Pods/ plant (No.)*	*Seeds/ pod (No.)*	*1000 seed wt (g)*	*Seed yield kg/ha*	*Straw yield kg/ ha*
Weedy check	12.0	22.4	4.71	3.7	49.0	1.5	230.51	1937	3431
Pendi. + Imaz. 960 g/ha PE	11.7	26.1	4.82	4.0	51.7	1.5	248.32	2205	3837
Propaqf. + Imaz. 93.7 g/ha PoE	11.9	26.9	4.87	4.0	52.3	1.5	250.67	2253	3921
Propaqf. + Imaz.125 g/ha PoE	12.4	27.6	4.87	4.3	52.3	1.7	252.07	2254	3944
Sod. Acif. + Clodina.P.183.7 g/ ha PoE	12.1	25.5	4.85	3.9	51.7	1.6	250.20	2243	3882
Sod. Acif. + Clodina.P.245 g/ha PoE	12.2	27.7	4.86	4.1	52.7	1.7	253.01	2260	3908
Fomsaf.+Fluazi.FB 165 g/haPoE	12.5	26.4	4.82	4.0	52.0	1.6	244.57	2105	3914
Fomsf. + Fluazi.FB 220 g/ha PoE	12.0	27.9	4.87	4.3	53.3	1.7	258.43	2254	3954
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

all the treatments. The better results are closely followed by propaquizafop 2.5% + imazethapyr 3.75 % 125 g *a.i.*/ha and sodium acifluorfen 16.5% EC + clodinafop-propargyl 8% EC 245 g *a.i.*/ha without any phytotoxic effect on soybean crop and no residual effect on succeeding chickpea crop.

References

Anonymous. 2020-21. Rajasthan Agricultural Statistics. Rajasthan Agricultural Statistics at a Glance. Agriculture Commissionerate, Rajasthan, Jaipur.

Anonymous. 2021. India Soy Forum. The SOPA, Indore, India.

Bagotiya, N., Choudhary, R., Choudhary, R.S. and Chaudhari, R. 2018. Effect of broad spectrum herbicides on weed dynamic, yield and economics of soybean production. *International Journal of Current Microbiology and Applied Sciences* **7**(8): 157-161.

Donald, C.M. and Hamblin, J. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Advances in Agronomy* **28**: 361-404.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agricultural Research (2nd ed.). John Willey and sons, Singapore.

Gupta, G.K., Sharma, A.N., Billore, S.D. and Joshi, O.P. 2006. Status and prospects of integrated weed management strategies in selected crops-soybean. (*In*) *Integrated Pest Management: Practices and Applications*. CBS Publishers. New Delhi *(Eds*). 2:198-233.

Harisha, S., Seenappa, C., Lalitha, B.S., Raddy, G. and Pandu, U. 2021. Bio-efficacy of new post emergence

herbicides on growth and yield of blackgram. *Indian Journal of Weed Science* **53**(1): 107-110.

Jadon, C.K., Dashora, L.N., Meena, S.N. and Singh, P. 2019. Growth, yield and quality of soybean [*Glycine max* (L.) Merrill.] as influenced by weed management and fertility levels in vertisols of S-E Rajasthan. *International Journal of Bio-resource and Stress Management* **10**(2):177-180.

Patel, R., Patidar, J. and Jain, K.K. 2021. Effect of different doses of fomesafen + fenoxaprop + chlorimuron-ethyl (ready-mix) against weeds in soybean. *Indian Journal of Weed Science* **53**(4): 433–435.

Simson, T.E., Adair, C.R., Kohler, G.P., Dabald, H.A., Kestar, F.B. and Hlick, J.T. 1965. Quality evaluation studies of foreign and domestic rices. *Tech. Bull. No. 1331*, USDA. pp. 1-16.

Varsheny, J. G. 1990. Chemical control of weed in soybean. *Indian Journal of Weed Science* **22**: 17-22.