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Effect of Different Weed Management Practices on Growth and Yield in Soybean Pigeonpea Intercropping System and its Residual Effect on Succeeding Crops

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A B S T R A C T

The field experiment was conducted at Agriculture Research Station, Anand Agricultural University, Derol, Dist: panchmahal, Gujarat, India during *kharif* seasons of the years 2017-18 and 2018-19. Ten treatments for weed management were studied in randomized block design with four replications to study the effect of different weed management practices on growth and yield in soybean - pigeonpea intercropping system and its residual effect on succeeding crops. Result of field experimentation, weeds could be managed by adopting weed management practices interculturing + hand weeding at 20 & 40 DAS or post - emergence application of imazamox 35% + imazethapyr 35% (Pre mix)70 g ha^{-1} PoE *fb* interculturing + hand weeding at 30 DAS was recorded higher growth, growth and yield attributes, soybean equivalent yield, gross returns, net returns, benefit cost ratio and none of the herbicides showed adverse effect on succeeding crops viz., maize, pearl millet and cucumber grown after harvest of soybean and pigeonpea without disturbing soil.

Introduction

Soybean considered as the 'Wonder legume'. It has outstanding nutritive value with 43% biological protein, 20% oil and is also very rich in vitamins, iron, mineral, salts and amino acids (Sangeetha *et al.,* 2013). Pigeonpea (*Cajanus cajan* (L.) Millsp.) commonly known as red gram, tur or arhar is the fifth prominent legume crop in the world. It has been recognized as a valuable source of protein for the vegetarians in their daily diet. It is grown as sole crop or intercrop with urdbean, mungbean, castor, sorghum, soybean, cotton, maize and groundnut in different states like Maharashtra, Karnataka, Andhra Pradesh, Gujarat, Jharkhand, Rajasthan Odisha, Punjab and Haryana. In rainy season weeds come in 2-3 flushes and growth is very fast therefore, they compete for light, nutrient, and space and are responsible for considerable reduction in yield. Weeds caused 80 % reduction in pigeonpea grain yield if weeds were allowed

to grow till harvest, however, grain yield losses were only 38% in pigeonpea + soybean intercropping system (Talnikar *et al.,* 2008).

Intercropping is the agricultural practice of growing two or more crops simultaneously on the same field with a definite row proportion. Weed suppression, the reduction of weed growth by crop interference, has been referred as one determinant of yield advantage of intercropping. The first 20-40 days period after sowing of soybean is considered to be critical with respect to weed crop competition. Weed competition during this period may lead to 40-70% reduction in the seed yield of soybean (Bhan, 1975) depending upon the weed species present.

Weeds are known to cause 40-64% reduction in pigeonpea yield. The critical period of crop weed competition for pigeonpea is 4-8 weeks (Ali, 1992) [1]. Among various constraints in crop production weed control is important one but generally neglected by many farmers.

The crop yield loss is 20 to 77 per cent due to weeds (Kurchania *et al.,* 2001). Inter cropping suppress the growth of weeds up to 25% (Sobney *et al.,* 1989). It is very essential to find out alternative to manual labour for weed control, which has more weed control efficiency. At present many promising and selective herbicides are available which can control weeds effectively. Therefore, the present study was conducted to study the effect of different weed management practices on growth and yield in soybean-pigeonpea intercropping system and its residual effect on succeeding crops. Herbicides proved important major in modern agriculture practices. With the intense farming practice and multiple cropping, the paucity of agricultural labour is seen. Their peak demand for a short period, inaccessible field conditions during crop seasons also encourages using herbicides in modern farming. But continuous application of herbicides in intence cropping system may leads to its residue accumulation in the soil. This persistence of an herbicide may limit the choice of succeeding crops. Therefore, residual studies essential to determine the feasibility of any herbicide. Summer maize, pearl millet and cucumber are important succeeding crops grown after soybean-pigeonpea intercrops in middle Gujarat region. Keeping this in view the present experiment is proposed.

Materials and Methods

Field experiment was carried out to study the effect of different weed management practices on growth and yield in soybean - pigeonpea intercropping system and its residual effect on succeeding crops The experiment was conducted at Agriculture Research Station, Anand Agricultural University, Derol, Dist: Panchmahal, Gujarat, India during *kharif* seasons of the years 2017-18 and 2018-19. The ten weed control treatments were studied viz., pendimethalin 1000 g ha^{-1}PE *fb* interculturing + hand weeding at 30 DAS, clomazone 1000 g ha^{-1}PE *fb* interculturing + hand weeding at 30 DAS, imazethapyr 75 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS, propaquizafop 75 g ha^{-1} PoE *fb* interculturing + hand weeding at 30 DAS, quizalofop ethyl 50 g ha^{-1} PoE *fb* interculturing + hand weeding at 30 DAS, fenoxaprop-p-ethyl 100 g ha^{-1} PoE *fb* interculturing + hand weeding at 30 DAS, imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS, sodium acefluorfen 16.5% + clodinafop propargyl 8% EC (Pre-mix) 80+165 PoE *fb* interculturing + hand weeding at 30 DAS, interculturing + hand weeding at 20 & 40 DAS and weedy check. The experiment was laid out in Randomized Block design with four replications. The plot size was 3.6 x 6.0 m. The soil of the experimental field was sandy loam in texture having low in

organic carbon and nitrogen, medium in available phosphorus and high in potassium. Pendimethalin and clomazonewas applied as pre emergence while imazethapyr, propaquizafop, quizalofop ethyl, fenoxaprop-p-ethyl, imazamox 35% + imazethapyr 35%and sodium acefluorfen 16.5% + clodinafop propargyl 8% EC were applied as post emergence with flat fan nozzle using 500 litre water per hectare. The soybean variety NRC 37 and pigeonpea variety AGT 2 were used in the experiment as a test crop. After harvesting of the soybean and pigeonpea crop the indicator plants was grown for bioassay study (up to 30 DAS). Three crops viz., maize, pearl millet and cucumber was grown in different row with minimum disturbance of the soil. The indicator plants was grown per plot two row of each crop for seed are sown maize (60 dibbles), pearl millet (120 dibbles) and cucumber (40 dibbles) in between the two row of previous crop pigeonpea stubbles without disturbance. All the recommended agronomic practices were followed for raising the crop during both the years of experimentation. The observations on growth and yield attributes were recorded. Observations on bio-assay study (germination (percent) at 10 DAS, plant height/shoot length, dry matter accumulation and root length of plant at 30 DAS) were recorded. Pooled analysis of two years was done and comparison was made at 5% level of significance.

Results and Discussion

Effects on growth and yield attributes

Plant height (cm)

The plant height at harvest of soybean is presented in (Table 1). Significantly higher plant height of soybean was recorded at harvest (74.9) by the treatment of T_9 (IC + HW at 20 & 40 DAS). Significantly lower plant height was observed under treatment T_{10} (weedy check). Plant height of pigeonpea was recorded at harvest as were not affected significantly due to different weed control treatments (Table 1). The higher value of weed control treatment may be assigned to the extent of crop weed competition significantly maximum plant height all successive stages because the interculturing + hand weeding at 20 & 40 DAS provided weed free condition at critical stage of crop weed competition and created favorable condition for growth parameters. Similar, result was obtained by Upadhyay *et al.,* (2012) in soybean and Jadhav (2015) in soybean + pigeonpea intercropping.

Branches plant^{-1}

Significantly more number of branches plant^{-1} soybean (3.8) and pigeonpea (10.2) was recorded at harvest under T_9 (IC + HW at 20 & 40 DAS), which was at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS) at 30 DAS (3.6) in soybean, while imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS (9.9), imazethapyr 75 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS (9.8), propaquizafop 75 g ha^{-1} PoE *fb* interculturing + hand weeding at 30 DAS (9.7), sodium acefluorfen 16.5% + clodinafop propargyl 8% EC (Pre mix) 80+165 PoE *fb* interculturing + hand weeding at 30 DAS (9.4) and quizalofop ethyl 50 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS (9.3) in pigeonpea. Significantly less number of branches plant^{-1} (soybean (2.0) and pigeonpea (6.5) was recorded by the treatment T_{10} (weedy check) (Table 1).

Similar, results were obtained by Upadhyay *et al.*, (2012) in soybean and Jadhav (2015) in soybean + pigeonpea intercropping.

Table.1 Growth and yield attributes as influenced by weed management practices in soybean-pigeonpea intercropping system (pooled of two years)

Tr. No.	Treatment	Plant height (cm) at harvest		Branches plant^{-1}		Pods plant^{-1}		100 seed weight (g)		Seed yield (kg ha^{-1})		Stover yield (kg ha^{-1})		Soybean equivalent yield (kg ha^{-1})	
		Soybean	Pigeon pea	Soybean	Pigeon pea	Soybean	Pigeon pea	Soybean	Pigeon pea	Soybean	Pigeon pea	Soybean	Pigeon pea	Seed	Stover
T_1	Pendimethalin 1000 g ha^{-1} PE *fb* IC + HW at 30 DAS	66.5^{b}	154.2	3.1^{d}	9.1^{b}	40.2^{e}	182.3^{d}	7.41^{c}	8.46^{a}	727^{c}	1101^{e}	1138^{c}	1271^{e}	2708^{c}	3680^{d}
T_2	Clomazone 1000 g ha^{-1}PE *fb* IC + HW at 30 DAS	65.5^{b}	151.8	3.1^{cd}	9.1^{b}	41.8^{de}	198.2^{cd}	7.47^{bc}	8.51^{a}	734^{c}	1165de	1148^{c}	1344de	2831^{c}	3837^{d}
T_3	Imazethapyr 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	68.1^{b}	158.8	3.5^{abc}	9.8^{ab}	48.1^{bc}	221.7^{abc}	7.98^{abc}	8.85^{a}	868^{b}	1329^{bc}	1358^{b}	1534^{bc}	3261^{b}	4425^{b}
T_4	Propaquizafop 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	66.8^{b}	159.3	3.3^{bcd}	9.7^{ab}	47.0^{cd}	215.3^{abc}	7.82^{bc}	8.83^{a}	861^{b}	1310^{bcd}	1348^{b}	1511^{bcd}	3220^{b}	4370^{b}
T_5	Quizalofop ethyl 50 g ha^{-1}PoE *fb* IC + HW at 30 DAS	66.8^{b}	160.5	3.2^{cd}	9.3^{ab}	44.7^{cde}	209.6^{bc}	7.72^{bc}	8.77^{a}	854^{b}	1303^{bcd}	1252^{bc}	1502^{bcd}	3199^{b}	4257^{bc}
T_6	Fenoxaprop -p-ethyl 100 g ha^{-1}PoE *fb* IC + HW at 30 DAS	65.6^{b}	156.0	3.2^{cd}	9.2^{b}	42.2^{cde}	199.8^{cd}	7.64^{bc}	8.64^{a}	749^{c}	1183^{cde}	1172^{c}	1365^{cde}	2878^{c}	3902^{cd}
T_7	Imazamox 35% + Imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* IC + HW at 30 DAS	68.7^{b}	162.5	3.6^{ab}	9.9^{ab}	54.1^{ab}	234.4^{ab}	8.09^{ab}	8.90^{a}	894^{ab}	1381^{ab}	1398^{ab}	1593^{ab}	3380^{ab}	4584^{ab}
T_8	Sodium acefluorfen 16.5% + Clodinafop propargyl 8% EC (Pre-mix) 80+165 PoE*fb* IC + HW at 30 DAS	67.6^{b}	159.1	3.3^{cd}	9.4^{ab}	45.7^{cd}	210.3^{bc}	7.82^{bc}	8.78^{a}	856^{b}	1305^{bcd}	1339^{b}	1505^{bcd}	3206^{b}	4349^{b}
T_9	IC + HW at 20 & 40 DAS	74.9^{a}	166.0	3.8^{a}	10.2^{a}	59.5^{a}	241.0^{a}	8.52^{a}	8.96^{a}	975^{a}	1482^{a}	1525^{a}	1709^{a}	3641^{a}	4944^{a}
T_{10}	Weedy check	57.1^{c}	149.3	2.0^{e}	6.5^{c}	21.3^{f}	142.6^{e}	6.81^{d}	7.72^{b}	61^{d}	514^{f}	95^{d}	591^{f}	986^{d}	1277^{e}
	S.Em ±	1.23	4.11	0.09	0.27	1.75	7.29	0.18	0.22	27.73	42.54	45.07	49.02	82.63	109.36
	F Test. 5 %	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	Interaction Y x T S.Em ±	1.75	6.22	1.14	0.41	2.58	10.98	0.26	0.33	41.89	62.28	66.74	72.00	123.03	161.98
	F Test. 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV%	5.24	7.89	8.48	8.87	11.63	10.69	6.67	7.61	11.06	10.32	11.34	10.34	8.40	8.18

Table.2 Economics as influenced by weed management practices in soybean-pigeonpea intercropping system (pooled of two years)

Tr. No.	Treatment	Soybean equivalent yield		Gross return (` ha^{-1})	Cost of cultivation (` ha^{-1})	Net return (` ha^{-1})	B:C ratio
		Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})				
T_1	Pendimethalin 1000 g ha^{-1} PE *fb* IC + HW at 30 DAS	2708^{c}	3680^{d}	84931	49525	35406	1.71
T_2	Clomazone 1000 g ha^{-1}PE *fb* IC + HW at 30 DAS	2831^{c}	3837^{d}	88779	49232	39547	1.80
T_3	Imazethapyr 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	3261^{b}	4425^{b}	102248	48908	53340	2.09
T_4	Propaquizafop 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	3220^{b}	4370^{b}	100959	48849	52110	2.07
T_5	Quizalofop ethyl 50 g ha^{-1}PoE *fb* IC + HW at 30 DAS	3199^{b}	4257^{bc}	100238	49444	50794	2.03
T_6	Fenoxaprop -p-ethyl 100 g ha^{-1}PoE *fb* IC + HW at 30 DAS	2878^{c}	3902^{cd}	90245	48816	41429	1.85
T_7	Imazamox 35% + Imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* IC + HW at 30 DAS	3380^{ab}	4584^{ab}	105971	49620	56351	2.14
T_8	Sodium acefluorfen 16.5% + Clodinafop propargyl 8% EC (Pre-mix) 80+165 PoE *fb* IC + HW at 30 DAS	3206^{b}	4349^{b}	100520	49931	50589	2.01
T_9	IC + HW at 20 & 40 DAS	3641^{a}	4944^{a}	114186	54187	59999	2.11
T_{10}	Weedy check	986^{d}	1277^{e}	30844	41151	-10307	0.75

Selling Price	
Seed: Soybean: ` 30.0 kg^{-1}	Stover: Soybean: ` 1.0 kg^{-1}
Pigeonpea: ` 54.0 kg^{-1}	Pigeonpea: ` 2.0 kg^{-1}

Table.3 Residual effect of weed management practices in succeeding crops (pooled of two years)

Tr. No.	Treatment	Germination (%) at 10 DAS			Plant height/ Shoot length (cm) at 30 DAS			Dry matter accumulation (g plant^{-1}) at 30 DAS			Root length (cm) at 30 DAS		
		Maize	Pearl millet	Cucumber	Maize	Pearl millet	Cucumber	Maize	Pearl millet	Cucumber	Maize	Pearl millet	Cucumber
T_1	Pendimethalin 1000 g ha^{-1} PE *fb* IC + HW at 30 DAS	92.08	87.19	86.25	48.2	50.6	4.5	1.04	1.54	0.21	16.81	16.2	8.5
T_2	Clomazone 1000 g ha^{-1}PE *fb* IC + HW at 30 DAS	91.67	84.06	81.88	47.2	49.6	4.2	1.03	1.50	0.20	17.18	16.1	8.0
T_3	Imazethapyr 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	94.38	83.44	84.69	48.9	46.9	4.6	1.06	1.49	0.21	16.87	16.0	7.4
T_4	Propaquizafop 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS	86.88	81.88	81.88	48.0	51.1	4.4	0.98	1.47	0.20	15.42	15.8	8.3
T_5	Quizalofop ethyl 50 g ha^{-1}PoE *fb* IC + HW at 30 DAS	91.25	82.40	82.50	48.8	50.2	4.6	1.03	1.47	0.21	17.76	16.6	8.2
T_6	Fenoxaprop -p-ethyl 100 g ha^{-1}PoE *fb* IC + HW at 30 DAS	88.54	88.23	80.00	44.3	47.1	4.4	1.00	1.58	0.20	16.67	17.0	8.5
T_7	Imazamox 35% + Imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* IC + HW at 30 DAS	93.33	84.59	82.50	48.1	49.7	4.4	1.05	1.51	0.20	16.94	16.4	8.1
T_8	Sodium acefluorfen 16.5% + Clodinafop propargyl 8% EC (Pre-mix) 80+165 PoE *fb* IC + HW at 30 DAS	92.08	84.27	83.13	48.8	47.6	4.6	1.04	1.51	0.21	16.41	16.2	8.2
T_9	IC + HW at 20 & 40 DAS	94.70	87.40	87.81	48.7	48.0	4.8	1.07	1.56	0.22	17.73	17.8	9.0
T_{10}	Weedy check	91.67	86.46	80.00	48.6	50.1	4.5	1.03	1.55	0.20	16.81	16.6	7.7
	S.Em ±	2.47	2.16	2.05	1.47	1.67	0.16	0.02	0.04	0.01	0.68	0.68	0.38
	F Test. 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Interaction Y x T S.Em ±	3.49	3.17	3.08	2.14	2.49	0.23	0.04	0.06	0.01	0.99	1.04	0.56
	F Test. 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV%	7.62	7.46	7.41	8.95	10.2	10.38	7.64	7.62	7.40	11.85	12.58	13.67

Pods plant^{-1}

Data regarding number of pods plant^{-1}of soybean and pigeonpea was recorded at harvest as influenced by weed management practices are presented in (Table 1). Significantly higher number of pods plant^{-1} (59.5 and 241.0) of soybean and pigeonpea was recorded by the treatment T_9 (IC + HW at 20 & 40 DAS), which was statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS) (54.1) except all other treatments in soybean, while which was statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* IC + HW at 30 DAS) (234.4) and T_3 (imazethapyr 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS) (221.7) except all other treatments in pigeonpea. Significantly lower number of pods plant^{-1} (21.3 and 142.6) of soybean and pigeonpea was recorded by the treatment T_{10} (weedy check). Response of pods bearing capacity of plant to various treatments was significant. The treatment could very well be explained in the light of competition stress and clean cultivation. In soybean and pigeonpea, maximum number of pods were recorded in treatment interculturing + hand weeding at 20 & 40 DAS followed by treatment imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS, The lowest number of pods per plant was recorded in weedy check. Similar result was reported by Mishra *et al.,* (2013) and Upadhyay *et al.,* (2012) in soybean.

100 seed weight (g)

Significantly higher number of seed weight (8.52) of soybean was recorded by the treatment T_9 (IC + HW at 20 & 40 DAS), which was statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS) (8.09) except all other treatments. Significantly lowest seed weight (6.81 g) was recorded by the treatment T_{10} (weedy check). Similar result was opined by Prachand *et al.,* (2014) in soybean. Significantly higher number of seed weight (8.96) was recorded by the treatment T_9 (IC + HW at 20 & 40 DAS), which was statistically at par with all other treatments except treatment T_{10} (weedy check) (7.72) (Table 1). Similar result was opined by Rao *et al.,* (2015) and Reddy *et al.,* (2016) in pigeonpea.

Seed yield (kg ha^{-1})

Data regarding seed yield (kg ha^{-1}) of soybean and pigeonpea was recorded as influenced by weed management practices in pooled are presented in (Table 1). The higher seed yield of soybean and pigeonpea (975 and 1482 kg ha^{-1}) was recorded under treatment T_9 (IC + HW at 20 & 40 DAS), found statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS). Significantly lowest seed yield of soybean and pigeonpea (61and 514 kg ha^{-1}) was recorded by the treatment T_{10} (weedy check).

Seed yield is an important parameter, which decides the efficiency superiority or stability of a particular treatment over treatments. The data of present investigation reveals that all weed control treatments, produced significantly higher seed yield over weedy check. Weed management due to different treatments at optimum time in the season, reduced crop weed competition at the lowest possible limit and provided almost weed free environment. Differences in crops yield were attributed to differences in weed control more the weeds present in treatment lesser will be the grain yield. It may probably the reason for higher yield in interculturing + two hand weeding at 20 & 40 DAS followed by aplication of imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at

30 DAS and imazethapyr 75 g ha^{-1}PoE *fb* IC + HW at 30 DAS. Similar result was opined by Kushwah and Vyas (2005), Habimana *et al.,* (2013) and Mishra *et al.,* (2013) in soybean. Upadhyay *et al.,* (2013), Rao *et al.,* (2015) and Reddy *et al.,* (2016) in pigeonpea. Jadhav (2015) in soybean-pigeonpea. The yield components like number of pods plant^{-1} and 100 seed weight are important in determining the crops yield potential. The crop weed competition in weedy check reduced the yield components in soybean and pigeonpea and thereby cause significant reduction in grain yield.

Stover yield (kg ha^{-1})

Data regarding stover yield (kg ha^{-1}) of soybean and pigeonpea crop was recorded as influenced by weed management practices are presented in (Table 1). The higher stover yield of soybean and pigeonpea (1525 and 1709 kg ha^{-1}) was recorded under treatment T_9 (IC + HW at 20 & 40 DAS), which was statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS), except all other treatments. Significantly lowest stover yield of soybean and pigeonpea (95 and 591 kg ha^{-1}) was recorded by the treatment T_{10} (weedy check). Increase in stover yield is directly related with increase in vegetative growth of the plant. The stover yield of soybean was affected significantly whereas, pigeonpea stover yield was significantly affected by weed control treatments. In both crop interculturing + hand weeding at 20 & 40 DAS was recorded higher stover yield and followed by application of imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* IC + HW at 30 DAS. The lowest stover yield per hectare was recorded in weedy check. Similar result was opined by Kushwah and Vyas (2005), Habimana *et al.,* (2013) and Mishra *et al.,* (2013) in soybean. Upadhyay *et al.,* (2013), Rao *et al.,* (2015) and Reddy *et al.,* (2016) in pigeonpea. Jadhav (2015) in soybean-pigeonpea.

Soybean equivalent yield

Data regarding equivalent seed and stover yield (kg ha^{-1}) of soybean was recorded as influenced by weed management practices are presented in (Table 1 and 2).The higher equivalent seed and stover yield of (3641 kg ha^{-1}and 4944 kg ha^{-1}) was recorded under treatment T_9 (IC + HW at 20 & 40 DAS), which was statistically at par with treatment T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS) (3380 kg ha^{-1}and 4584 kg ha^{-1}). Significantly lowest equivalent seed and stover yield of (986 kg ha^{-1}and 1277 kg ha^{-1}) was recorded by the treatment T_{10} (weedy check). The soybean-equivalent yield was worked out considering price of soybean and pigeonpea. The observation on SEY kg ha^{-1} indicated that significant difference due to various treatments. Interculturing + hand weeding at 20 & 40 DAS recorded significantly higher SEY than all other treatments except application of imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb* IC + HW at 30 DAS. The lowest SEY recorded in weedy check. Similar result was reported by Kushwah and Vyas (2005) in soybean. Jadhav (2015) and Ilhe *et al.,* (2017) in soybean-pigeonpea.

Economics

Data on economics of the different treatments presented in (Table 2) indicated maximum gross return and net return (`114186 and 59999 ha$^{-1}$) was achieved under treatment $T_9$ (IC + HW at 20 & 40 DAS) and $T_7$ (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha$^{-1}$ PoE *fb* IC + HW at 30 DAS) (`105971 and 56351 ha^{-1}). The benefit cost ratio was also higher in T_7 (imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1} PoE *fb*

IC + HW at 30 DAS) (2.14) followed by treatment T_9 (IC + HW at 20 & 40 DAS) (2.11). The treatment T_{10} (weedy check) had lowest benefit cost ratio (0.75) due to poor yield in this treatment. The results are in conformity with the results of Mishra *et al.*, (2013), Upadhyay *et al.*, (2012) and Moghal *et al.*, (2014).

Effect of applied herbicides on succeeding crops

Data pertaining to germination (%), plant height/shoot length (cm),dry matter accumulation (g plant^{-1}) and root length (cm) of succeeding maize, pearl millet and cucumber crops revealed that did not differ significantly due to residual effect of herbicides applied in preceding crop (Table 3). This indicated that herbicides was applied in preceding crop had no adverse effect on germination of succeeding crops. These findings are in confirmation with findings of Sangeetha *et al.*, (2012) and Patel *et al.*, (2016_a).

From the results of field experimentation, it can be concluded that weeds could be managed by adopting weed management practices interculturing + hand weeding at 20 & 40 DAS or post - emergence application of imazamox 35% + imazethapyr 35% (Pre mix) 70 g ha^{-1}PoE *fb* interculturing + hand weeding at 30 DAS was recorded higher growth, growth and yield attributes, soybean equivalent yield, gross returns, net returns, benefit cost ratio and none of the herbicides showed adverse effect on succeeding crops viz., maize, pearl millet and cucumber grown after harvest of soybean and pigeonpea without disturbing soil.

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