

Original Research Article

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Effect of Planting Pattern and Weed Management Practices on Weeds and Yields of Field Pea and Baby Corn in Field Pea + Baby Corn Intercropping System

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ABSTRACT

A field experiment was conducted during two consecutive seasons of *rabi* 2011-13 at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar to find out the effect of planting pattern and weed management practices on weed growth and yields of field pea and baby corn in field pea (Pant P-13) + baby corn (Surya) intercropping system. The experiment was laid out in split plot design keeping four planting patterns as main plot and four weed management practices as sub plot with three replications. Paired planting of maize (30/60 cm) + field pea (2:2) and planting of maize + field pea (1:1) had lower total weed density and weed dry weight and higher weed control efficiency than sole planting of field pea or baby corn. Sole planting of field pea recorded significantly higher grain (2264 and 1434 kg ha⁻¹) and straw yields (3263 and 2540 kg ha⁻¹) during 2011-12 and 2012-2013 than yield obtained as a component crop in paired planting of maize (30/60 cm) + field pea (2:2) and planting of maize + field pea (1:1). Baby corn yield was similar in sole, paired (2:2) and 1:1 planting but significantly higher stover yield of baby corn (3576 kg ha⁻¹ and 3533 kg ha⁻¹, during 2011-12 and 2012-2013 respectively) was obtained from sole crop than other planting methods during both the years. Both the intercropping systems had significantly higher field pea equivalent yield than sole crop of either field pea or baby corn. The lowest total weed density (66.5 and 67.3 plants/m², during 2011-12 and 2012-2013 respectively) and weed dry weight (99.4 and 99.7 g m⁻², during 2011-12 and 2012-2013 respectively) was recorded in hand weeding at 90 days after sowing which was followed by pre-emergence application of pendimethalin 1 kg ha⁻¹, post-emergence application of imazethapyr 50 g ha⁻¹ and weedy check. Significantly higher weed control efficiency was recorded from one hand weeding (56.07 and 56.52%) and pre-emergence application of pendimethalin 1 kg ha⁻¹ (55.37 and 56.49%) during 2011-2012 and 2012-2013 than post emergence application of imazethapyr 50 g ha⁻¹ (30.08 and 30.36% respectively). Hand weeding, pre-emergence application of pendimethalin 1 kg ha⁻¹ and post-emergence application of imazethapyr 50 g ha⁻¹ (30 days after sowing) improved all the growth and yield parameters of field pea and baby corn than weedy check. Hand weeding, pre-emergence application of pendimethalin 1 kg ha⁻¹ and post-emergence application of imazethapyr 50 g ha⁻¹ had significantly higher field pea equivalent yield than weedy check.

Keywords

Baby corn, Field pea equivalent yield, Field pea, Planting pattern

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Introduction

Intercropping of cereals with pulses is an age old practice. Pulses can do wonder when intercropped with widely spaced crops like maize, sorghum, pearl millet, cotton and sugarcane particularly in Northern India (Punjab, Haryana, Uttar Pradesh, Rajasthan, Bihar). There are evidences that intercropping of short growing grain legumes with tall cereals give higher productivity than corresponding sole crops (Rao and Willey, 1983). Field pea (*Pisum sativum*), one of the important pulse crop of winter season has great potential to contribute to the pulse basket in India. Maize, the queen of cereals, is cultivated worldwide round the year.

During the recent past, it has been used as vegetable where unfertilized cob is used for cooking purpose, popularly known as baby corn (*Zea mays* L.) (Barod *et al.*, 2012). Introduction of baby corn during off season (winter months), because of its photo and thermo insensitiveness will promote nutritive dish of the people and also fetch additional income to farming community. Normally baby corn is planted in wider rows and a considerable portion of the incident solar radiation remains un-intercepted due to poor canopy development because of its slow growth during winter season. Slow crop growth during winter months provide ample opportunity to the growth of weeds. Maintenance of adequate crop cover turns the competition in favour of crop. Intercropping itself has been found helpful in limiting weed population by way of cutting light to them. So field pea may be introduced between the rows of baby corn. Intercropping of legumes with maize has been found to give yield advantage owing to efficient utilization of growth resources and maintenance of soil health (Singh *et al.*, 1998). Mishra (2014) reported

that maize + field pea intercropping system resulted an extra advantage of 85.6 per cent in terms of maize equivalent yield over sole maize. Weed suppression in intercropping through more efficient use of environmental resources by component crops has also been reported by Mashingaizde *et al.*, (2000).

Development of feasible and economically viable intercropping system depends largely on adoption of proper planting pattern as well as weed management. Efficiency of production in intercropping system could be improved by minimizing inter-specific competition between the component crops. Planting pattern alters the space available to individual plant; hence the degree of competition for natural resources becomes variable between component crops. Appropriation of suitable planting pattern is thus, necessary to bring the competition to the minimum level. Chalka and Nepalia (2005) at Navsari, Gujarat indicated that when soybean and cowpea were intercropped with maize in 2:1 row ratio, there was marked reduction in weed density and dry weight compared to sole maize. Weeds are one of the major obstacles that severely affect the productivity and quality of the component crops. Weeds compete with the crop plants for nutrients, moisture and light and thus, reduce the yield considerably. Keeping the above points in view, the experiment was conducted to see the response of weeds, field pea and baby corn to planting pattern and weed management on field pea + baby corn intercropping system.

Materials and Methods

The experiment was conducted during *rabi* seasons of 2011-12 and 2012-13 in Dr. Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (29^oN, 79.3^oE and 243.84 m above mean sea level).

The maximum temperature during the crop season of 2011-12 and 2012-13 ranged between 17.5-36.5°C and 12.0-40.6°C, respectively. The minimum temperature during the same period ranged between 3.7-21.5°C and 2.5-23.7°C, respectively. A total rainfall of 1.16 mm and 5.44 mm were received during the crop season of 2011-12 and 2012-13 respectively. There was frost in the second fortnight of January during 2012-2013. The soil was sandy loam in texture with high in organic carbon(0.79%), low in available nitrogen (210.6 kg N ha⁻¹) and medium in available phosphorus (16.5kg P ha⁻¹) and potassium contents (184.7kg K ha⁻¹) and neutral in soil reaction (pH 7.3). The experiment was laid out in split-plot design with three replications. Main plot consisted of four planting patterns *viz.* field pea sole (30 cm), baby corn sole (45 cm), planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) and sub-plot consisted of four weed management practices *viz.* weedy check, hand weeding at 30 days after sowing (DAS), pre-emergence (PE) application of pendimethalin 1 kg ha⁻¹ and post-emergence (POE) application of imazethapyr 50 g ha⁻¹ at 30 DAS. Maize crop was fertilized with 120, 60 and 40 kg ha⁻¹ of N, P₂O₅ and K₂O through urea, single super phosphate and muriate of potash respectively. Half dose of nitrogen and full dose of P₂O₅ and K₂O were applied as basal in all the plots and remaining dose of N was applied at knee high stage of the crop as top dressing. A dose of 18 kg N, 48 kg P₂O₅ and 24 kg K₂O ha⁻¹ was applied to field pea sole through NPK mixture (12:32:16) applied @150 kg ha⁻¹ as basal. No additional dose of fertilizer to pea was given to intercropping system.

The weeds falling within the quadrat (50cm×50cm) were counted to obtain weed population. For obtaining dry weight of weeds, weeds within the quadrat were removed, sun dried in a hot air oven at 65±5°C

till the constant weight. Weed control efficiency (WCE) was calculated based on the dry weight of weeds obtained at 90 DAS i.e. at maximum dry weight stage with the help of following formula:

$$WCE = \frac{\text{Dry matter of weeds in weedy plot} - \text{Dry matter of weeds in treated plot}}{\text{Dry matter of weeds in weedy plot}} \times 100$$

Nitrogen, phosphorus and potassium content in weeds were estimated from dry matter accumulation at 90 days after sowing. Oven dried weed samples were ground with the help of Willey mill grinder. Total nitrogen, phosphorus and potassium contents were estimated by modified Kjeldahl method, Vanado-molybdo yellow phosphoric spectrophotometric and flame photometric methods respectively (Jackson, 1973). The nutrient uptake by grain and straw of field pea and baby corn for each plot was calculated as follows:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)} \times \text{Oven dry weight (kg ha}^{-1}\text{)}}{100}$$

Picking of baby corn cobs were done three days after silking of the cobs with hand. The fresh weight of baby corn after removing the husk per picking for each net plot was summed up to get total weight of baby corn per plot.

Crop equivalent yield (CEY) was calculated by using the following formula:

$$Y_1P_1 = Y_2P_2,$$

where Y₁ and Y₂ are the yields of component 1 and 2 respectively and P₁ and P₂ are the prices of component 1 and 2 respectively.

The data collected for various parameters were subjected to the analysis by using STPR-1, programme developed by Department of Statistics and Mathematics, College of Basic Science and Humanities, Pantnagar. Comparison of treatment means was done using critical differences (CD) at 5 per cent level of significance.

Results and Discussion

Total weed density

Weed flora of experimental field consisted of sedges, grassy and broad leaf weeds. Of the weed species identified, three species were prominent viz. *Phalaris minor*, *Cyperus rotundus* and *Argemone maxican* under weedy check. The total weed population recorded at different stages in weedy check plot revealed that the crop was severely infested with weeds throughout the growth period. The density of weeds increased up to 60 days stage of crop growth and there after started decreasing. The lowest density was observed at 120 days stage in all the treatments (Table 1). The lowest weed density in the later stage was the result of drying of weeds because of intense competition among the weeds during subsequent growing period of crop and decaying of weeds due to termination of their life cycle as weeds usually have shorter life span than crop plants. Both the intercropping systems recorded lower total weed density than the sole cropping of field pea or baby corn during both the years. Lower total weed density observed in intercropping systems than sole planting of field pea or baby corn was due to the fact that intercropping provides an efficient utilization of environmental resources especially the light. Thus, the growth of weeds, depending on the availability of environmental resources was decreased. Weed suppression in intercropping through more efficient use of environmental resources by component crops has also been

reported by Poggio (2005). Sole and intercropped field pea reduced the population and dry weight of weeds more than that of baby corn sole due to its smothering effect. Kurchania *et al.*, (1995), Dubey (1998) and Sanjay *et al.*, (2011) also reported similar findings. Hand weeding (30 DAS) recorded the lowest total weed density which was followed by PE application of pendimethalin 1 kg ha⁻¹, POE application of imazethapyr 50 gha⁻¹ (30 DAS) and weedy check. Variation in the density of weeds in different weed control treatments was due to varying effect of herbicides and hand weeding on number of weeds per unit area. These results are in line with those obtained by Khan *et al.*, (2002), Muhammad and Hassan (2003) and Fathiet *al.*, (2003); they reported the highest weed density in weedy check plots and the lowest with chemical weed control. The interaction between planting patterns and weed management practices at 90 DAS was significant during both the years with respect to total weed density (Table 2). Both the intercropping systems recorded lower total weed density than sole planting of field pea and baby corn under all weed management practices during both the years. The lowest total weed density was observed in hand weeding at 30 DAS which was followed by PE application of pendimethalin 1 kg ha⁻¹, POE application of imazethapyr 50 g ha⁻¹ at 30 DAS and weedy check under all the planting patterns.

Total dry matter of weeds

The maximum dry matter production of the weeds occurred at 90 days stage, although the highest weed population was observed at 60 days stage (Table 3). This indicated that maximum flush of weeds emerged with the emergence of crop and increased the dry matter accumulation by individual weed with the advancement of crop growth. Both the intercropping systems showed lower weed dry

weight than sole field pea and baby corn. The lower weed dry weight in case of intercropping than that of sole planting was the result of reduction in total weed density in intercropping systems and its reduced growth as a result of more photosynthetically active radiation (PAR) interception and also greater water and nutrients extraction by intercrops. Katsaruware and Manyanhaire (2009) concluded that maize + cowpea intercropping reduced weed biomass when compared to sole crops which was as a result of limited availability of resources to weed species, where incoming PAR reaching the ground was reduced by maize + cowpea intercrops. Higher weed dry weight in baby corn sole (45 cm) than field pea sole (30 cm) was also due to higher weed density in sole baby corn. These results are in accordance with those of Sanjay *et al.*, (2011) who reported the highest weed dry matter production under sole maize which was higher than sole blackgram and intercropping systems. Weedy check plots had significantly higher dry weight of weeds than hand weeded and herbicide treated plots. The maximum dry weight of weeds in weedy check plots was due to more number of weeds and their growth. Decrease in dry weight of weeds in different weed control treatments was due to varying degree of weed suppressing ability of management practices. These results corroborate the findings of Devender *et al.*, (1998) and Saini (2000) who reported that dry weights of all weed species were significantly reduced under hand weeding and chemical weed control treatments.

Weed control efficiency

Paired planting of maize (30/60 cm) + field pea (2:2) being at par with planting of maize + field pea (1:1) had significantly higher weed control efficiency than field pea sole (30 cm) and baby corn sole (45 cm) planting during 2011-12. During 2012-13, paired planting of

maize (30/60 cm) + field pea (2:2) computed significantly higher weed control efficiency than remaining planting pattern treatments (Table 4). Higher weed control efficiency (WCE) in intercropping systems as compared to sole cropping was due to better suppression of weeds by intercropping systems as evidenced by reduced weed density and dry matter accumulation as a result of better utilization of resources by the component crops. Among the weed management practices, hand weeding (30 DAS) had statistically similar weed control efficiency as PE application of pendimethalin 1 kg ha⁻¹, both these treatments had significantly higher weed control efficiency than POE application of imazethapyr 50 g ha⁻¹ (30 DAS) during both the years. Comparatively higher weed control efficiency observed in hand weeded and herbicide treated plots than weedy check treatment could be attributed to the lower density as well as dry matter accumulation by weeds in these treatments. Lower weed control efficiency among the herbicides was associated with POE application of imazethapyr 50 g ha⁻¹ (30 DAS). It might be due to higher weed intensity and dry matter accumulation of weeds in this treatment. These results corroborate with the findings of Saini and Angiras (1998) and Sreenivas and Satyanarayana (1994).

Nutrient (N, P and K) content and their uptake by weeds

Planting patterns and weed management practices had no significant effect on nitrogen, phosphorus and potassium content of weeds during both the years (Table 5). Uptake of nutrients (N, P and K) by weeds found in sole baby corn or field pea sole was higher than that in both the intercropping systems although the differences were non-significant (Table 6). Higher accumulation of weed dry matter in sole planting resulted in more nutrient removal by weeds as total nutrient

uptake by weeds is a function of total dry matter and nutrient concentration present in the weeds. The results agreed with the findings of Sanjay *et al.*, (2011) who reported maximum nitrogen removal by weeds in sole maize than under sole blackgram as well as intercropping systems. Weeds of the weedy check plot had significantly higher nutrient uptake (N, P and K) than that of the hand weeded and herbicide treated plots. The reason for higher nutrient uptake in weedy check plots was due to higher dry matter accumulation by the weeds under this treatment.

Grain yield of field pea per hectare

During 2011-12, sole planting of field pea (30 cm) produced the highest grain yield (2264 kg ha⁻¹) which was followed by paired planting of maize (30/60 cm) + field pea (2:2) (1528 kg ha⁻¹) and planting of maize + field pea (1:1) (1108 kg ha⁻¹) (Table 7). All these treatments differed significantly from one another.

During 2012-13, field pea sole (30 cm) produced significantly higher grain yield (1435 kg ha⁻¹) than planting of maize + field pea (1:1) (888 kg ha⁻¹) and paired planting of maize (30/60 cm) + field pea (2:2) (764 kg ha⁻¹). The difference between planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) was non-significant. On an average, sole planting of field pea yielded 85.3 and 61.4 per cent more grain yield over planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) respectively. Higher yield of field pea in the treatments where it was grown alone might be due to higher planting density, plant height and higher values of yield attributing characters like number of pods per plant, grains per pod and grain yield per plant. The lower grain yield of field pea grown in

association with baby corn was probably the result of inter-specific competition between corn and field pea plants for below and above ground growth factors i.e. soil moisture, nutrient, space and solar radiation. Also lower grain yield in intercropped plots may be due to shading effect of baby corn on field pea due to variation in plant architecture and aggressive effect of C₄ plant (baby corn) on C₃ plant (field pea). The results of present investigation are in conformity with those of Carruthers *et al.*, (2000), Banik *et al.*, (2006) and Das *et al.*, (2013) who reported the highest grain yield of soybean under sole planting which was statistically different from those obtained from maize + soybean at single row and maize + soybean at paired row arrangement. Reduction in the grain yield of urdbean (Upasani *et al.*, 2000) and common bean (Maingi *et al.*, 2000) when intercropped with maize has also been reported. Hand weeding (30 DAS) recorded significantly higher grain yield than remaining weed management practices during both the years. The difference in grain yield obtained from PE application of pendimethalin 1 kg ha⁻¹ POE application of imazethapyr 50 g ha⁻¹ (30 DAS) was non-significant. Both these treatments had significantly higher grain yield than weedy check. On an average, hand weeding (30 DAS), PE application of pendimethalin 1 kg ha⁻¹ and POE application of imazethapyr 50 g ha⁻¹ (30 DAS) yielded 50.8, 31.6 and 24.0 per cent higher yield over weedy check respectively. The higher grain yield in these treatments could be attributed to improve yield components such as more number of pods per plant, number of grains per pod, grain yield per plant etc. The improvement in yield components was in turn due to improved growth attributes such as higher total dry matter production and higher crop growth rate and relative growth rate, more nodules per plant etc.

Table.1 Effect of planting patterns and weed management practices on total weed density (plants/m²) during 2011-12 and 2012-13

Treatment	Total weed density (plants/m ²)							
	30 DAS		60 DAS		90 DAS		120 DAS	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Planting pattern								
Field pea sole (30 cm)	5.24(203.7)	5.19(190.4)	4.82(141.1)	4.86(145.9)	4.64(115.2)	4.65(116.3)	4.09(65.3)	4.02(61.2)
Baby corn sole (45 cm)	5.12(176.4)	5.23(198.1)	5.24(207.0)	5.35(229.9)	4.87(145.6)	4.95(154.1)	4.18(71.1)	3.90(53.9)
Planting of maize + field pea (1:1)	5.21(193.9)	5.17(185.1)	4.77(133.2)	4.80(136.7)	4.59(108.8)	4.59(109.1)	3.98(57.1)	3.93(53.7)
Paired planting of maize (30/60 cm)+field pea (2:2)	5.12(178.0)	5.06(165.4)	4.72(125.0)	4.76(131.9)	4.47(95.9)	4.45(94.9)	3.84(49.7)	3.78(46.4)
S.Em.±	0.04(7.91)	0.03(6.7)	0.03(8.5)	0.03(6.4)	0.04(6.2)	0.07(11.5)	0.04(2.5)	0.06(4.3)
CD at 5%	NS	NS	0.13(29.5)	0.13(22.0)	0.15(21.6)	0.25(39.6)	0.17(8.6)	NS
Weed management								
Weedy	5.34(209.9)	5.32(206.3)	5.54(260.0)	5.60(276.1)	5.27(197.8)	5.27(198.0)	4.56(97.6)	4.45(87.7)
Hand weeding (30 DAS)	5.42(229.2)	5.42(228.4)	4.45(86.8)	4.47(89.6)	4.19(66.5)	4.20(67.3)	3.65(38.0)	3.44(30.6)
Pendimethalin 1 kg ha ⁻¹ (PE)	4.59(98.6)	4.63(103.2)	4.83(127.4)	4.87(133.5)	4.51(92.4)	4.55(96.4)	3.85(47.5)	3.77(43.5)
Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	5.36(214.2)	5.29(201.1)	4.74(132.1)	4.82(145.1)	4.60(108.8)	4.62(112.8)	4.05(60.1)	3.96(53.5)
S.Em.±	0.02(4.6)	0.03(7.1)	0.03(6.8)	0.03(8.3)	0.03(6.7)	0.05(7.5)	0.03(3.0)	0.04(3.0)
CD at 5%	0.07(13.6)	0.10(20.7)	0.11(19.8)	0.10(24.3)	0.11(19.5)	0.16(21.9)	0.10(8.6)	0.12(8.9)

*original values are in parentheses and values outside the parenthesis are log (x+1) transformed; DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.2 Interaction between planting pattern and weed management on total weed density at 90 day during 2011-12 and 2012-13

Planting pattern	Total weed density							
	2011-12				2012-13			
	Weedy	Hand weeding (30 DAS)	Pendimethalin 1 kg ha ⁻¹ (PE)	Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	Weedy	Hand weeding (30 DAS)	Pendimethalin 1 kg ha ⁻¹ (PE)	Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)
Field pea sole (30 cm)	5.31 (207.2)	4.27 (73.2)	4.58 (97.6)	4.40 (82.8)	5.33 (210.7)	4.23 (69.0)	4.61 (101.1)	4.44 (84.4)
Baby corn sole (45 cm)	5.33 (211.0)	4.27 (71.4)	4.64 (105.5)	5.25 (194.3)	5.37 (218.7)	4.43 (83.9)	4.72 (114.5)	5.27 (199.3)
Planting of maize + field pea (1:1)	5.29 (198.8)	4.19 (65.6)	4.48 (90.8)	4.39 (80.0)	5.24 (193.9)	4.16 (63.9)	4.55 (94.2)	4.41 (84.4)
Paired planting of maize (30/60 cm) + field pea (2:2)	5.16 (174.0)	4.04 (56.0)	4.33 (75.6)	4.36 (78.0)	5.13 (168.6)	3.97 (52.4)	4.31 (75.9)	4.38 (82.9)
		S.Em.±		CD at 5%	S.Em.±		CD at 5%	
Comparison between two planting patterns at same weed management		0.08 (13.3)		0.23 (38.9)	0.11 (14.9)		0.32 (43.8)	
Comparison between two weed managements at same planting pattern		0.08 (13.1)		0.25 (39.9)	0.12 (17.3)		0.38 (54.6)	

* Original values are in parentheses and values outside the parenthesis are log (x+1) transformed; DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.3 Effect of planting patterns and weed management practices on dry weight of weeds during 2011-12 and 2012-13

Treatment	Weed dry weight (g m ⁻²)							
	30 DAS		60 DAS		90 DAS		120 DAS	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Planting pattern								
Field pea sole (30 cm)	26.5	27.7	88.5	92.9	156.9	158.0	130.0	133.7
Baby corn sole (45 cm)	28.3	28.2	99.1	104.1	158.8	159.9	118.6	121.9
Planting of maize + field pea (1:1)	28.3	26.1	83.0	87.2	143.4	145.3	125.0	129.5
Paired planting of maize (30/60 cm) + field pea (2:2)	26.0	26.3	79.1	83.1	125.7	128.9	111.1	113.6
S.Em.±	0.9	1.4	3.3	3.4	9.9	8.4	5.0	9.9
CD at 5%	NS	NS	11.5	11.6	NS	NS	NS	NS
Weed management								
Weedy	30.9	31.4	152.8	160.4	227.3	231.6	194.9	201.7
Hand weeding (30 DAS)	30.4	29.8	58.8	61.7	99.4	99.7	84.1	85.7
Pendimethalin 1 kg ha ⁻¹ (PE)	17.1	15.2	66.5	69.8	99.9	98.9	88.4	90.1
Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	30.7	31.9	71.7	75.3	158.1	162.0	117.3	121.4
S.Em.±	1.3	1.5	5.0	6.1	6.8	7.3	8.5	7.9
CD at 5%	3.7	4.3	14.7	17.9	19.9	21.3	24.8	23.1

DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.4 Effect of planting patterns and weed management practices on weed control efficiency (WCE) during 2011-12 and 2012-13

Treatment	Weed control efficiency (%)	
	2011-12	2012-13
Planting pattern		
Field pea sole (30 cm)	44.33	43.16
Baby corn sole (45 cm)	44.08	42.16
Planting of maize + field pea (1:1)	47.51	49.43
Paired planting of maize (30/60 cm) + field pea (2:2)	52.77	56.40
S.Em.±	1.55	1.72
CD at 5%	5.38	5.96
Weed management		
Weedy	–	–
Hand weeding (30 DAS)	56.07	56.52
Pendimethalin 1 kg ha ⁻¹ (PE)	55.37	56.49
Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	30.08	30.36
S.Em.±	0.93	1.10
CD at 5%	2.81	3.31

DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.5 Effect of planting patterns and weed management practices on nutrient content of weeds during 2011-12 and 2012-13

Treatment	Nutrient content (%)					
	Nitrogen		Phosphorus		Potassium	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Planting pattern						
Field pea sole (30 cm)	2.06	2.09	0.36	0.36	2.29	2.32
Baby corn sole (45 cm)	2.08	2.10	0.38	0.38	2.31	2.33
Planting of maize + field pea (1:1)	2.07	2.09	0.36	0.37	2.30	2.33
Paired planting of maize (30/60 cm) + field pea (2:2)	2.06	2.08	0.37	0.37	2.29	2.32
S.Em.±	0.09	0.04	0.03	0.03	0.05	0.05
CD at 5%	NS	NS	NS	NS	NS	NS
Weed management						
Weedy	2.07	2.10	0.37	0.38	2.30	2.33
Hand weeding (30 DAS)	2.07	2.10	0.38	0.38	2.31	2.33
Pendimethalin 1 kg ha ⁻¹ (PE)	2.07	2.09	0.36	0.36	2.29	2.32
Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	2.05	2.07	0.35	0.36	2.29	2.32
S.Em.±	0.04	0.02	0.007	0.01	0.01	0.01
CD at 5%	NS	NS	NS	NS	NS	NS

DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.6 Effect of planting patterns and weed management practices on nutrient uptake (kg ha^{-1}) by weeds during 2011-12 and 2012-13

Treatment	Uptake (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Planting pattern						
Field pea sole (30 cm)	32.56	33.12	5.75	5.77	36.26	36.69
Baby corn sole (45 cm)	33.14	33.61	5.94	6.15	36.72	37.39
Planting of maize + field pea (1:1)	29.90	30.43	5.26	5.39	33.03	33.94
Paired planting of maize (30/60 cm) + field pea (2:2)	25.68	26.79	4.63	4.79	28.88	29.90
S.Em.±	2.21	1.79	0.41	0.37	2.67	2.22
CD at 5%	NS	NS	NS	NS	NS	NS
Weed management						
Weedy	47.26	48.68	8.61	8.87	52.67	54.14
Hand weeding (30 DAS)	20.74	20.95	3.74	3.79	22.94	23.26
Pendimethalin 1 kg ha^{-1} (PE)	20.79	20.66	3.61	3.60	22.94	22.90
Imazethapyr 50 g ha^{-1} (POE, 30 DAS)	32.48	33.66	5.64	5.84	36.34	37.63
S.Em.±	1.48	1.70	0.35	0.40	1.76	1.79
CD at 5%	10.66	10.54	2.25	2.37	12.79	11.83

DAS: days after sowing; PE: pre emergence; POE: post emergence

Table.7 Effect of planting patterns and weed management practices on grain and straw yields of field pea and baby corn and stover yield of baby corn during 2011-12 and 2012-13

Treatment	Field pea yield (kg ha ⁻¹)				Baby corn (kg ha ⁻¹)				Field pea grain equivalent yield	
	Grain		Straw		Baby corn		Stover		2011-12	2012-13
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13		
Planting pattern										
Field pea sole (30 cm)	2264	1434	3263	2540	-	-	-	-	2264	1435
Baby corn sole (45 cm)	-	-	-	-	812	810	3576	3533	1505	1398
Planting of maize + field pea (1:1)	1108	888	2885	2032	792	733	1615	1572	2574	2154
Paired planting of maize (30/60 cm) + field pea (2:2)	1528	764	2592	1946	807	746	1823	1780	3022	2052
S.Em.±	58	43	80	62	19	23	35	71	68	46
CD at 5%	229	168	312	242	NS	NS	136	278	236	159
Weed management										
Weedy	1268	835	2754	2047	684	387	1968	1925	1900	1128
Hand weeding (30 DAS)	1947	1225	3108	2298	952	896	2616	2573	2783	2078
Pendimethalin 1 kg ha ⁻¹ (PE)	1700	1068	2849	2194	801	990	2731	2688	2387	2082
Imazethapyr 50 g ha ⁻¹ (POE, 30 DAS)	1620	987	2943	2152	778	780	2037	1994	2295	1750
S.Em.±	38	36	62	34	23	8	69	44	41	40
CD at 5%	113	106	184	102	69	25	206	130	122	117

DAS: days after sowing; PE: pre emergence; POE: post emergence

Thus, the improvement in growth and yield components was as a consequence of lower crop-weed competition, which shifted the balance in favor of crop in the utilization of nutrients, moisture, light and space. Mundra *et al.*, (2003) found that the pre emergence application of atrazine at 0.5 kg ha^{-1} + intercultivation at 35 DAS tended to increase mean grain yield by 92.8 per cent over weedy check. The increased yield during 2011-12 than in 2012-13 growing season could be attributed to the greater competitive ability of field pea during that growing season as a result of the favorable weather condition. During 2012-13, there was frost in the month of January-February thereby extending the cold period which resulted yield reduction.

Straw yield of field pea per hectare

Sole planting of field pea (30 cm) produced significantly higher straw yield than planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) during both the years (Table 7). The difference between planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) was non-significant. On an average, increased in straw yield in sole planting of field pea than planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) was 18.0 and 27.9 per cent respectively. This was mainly due to higher plant population in sole planting of field pea. Similar results were reported by Mandal *et al.*, (2014_a) who reported significantly lower straw yield of intercropped soybean and groundnut than in monocropping. During 2011-12, POE application of imazethapyr 50 g ha^{-1} (30 DAS) being at par with PE application of pendimethalin 1 kg ha^{-1} produced significantly higher straw yield than weedy check. The difference in straw yield between PE application of pendimethalin 1 kg ha^{-1} and weedy check was non-significant. During 2012-13, hand weeding (30 DAS)

produced significantly higher straw yield than remaining weed management practices. PE application of pendimethalin 1 kg ha^{-1} produced statistically similar straw yield as post emergence application of imazethapyr 50 g ha^{-1} (30 DAS), both these treatments had significantly higher straw yield than weedy check. On an average, hand weeding (30 DAS), pre emergence application of pendimethalin 1 kg ha^{-1} and post emergence application of imazethapyr 50 g ha^{-1} (30 DAS) yielded 12.6, 5.0 and 6.1 per cent higher straw yield over weedy check respectively.

Baby corn yield per hectare

The yield of baby corn under different planting patterns was statistically similar during both the years (Table 7). The results of the present investigation are in accordance with those of Mandal *et al.*, (2014_b) who found that maize crop produced the highest grain yield in sole cropping which was statistically at par with intercropping situations like maize + soybean (1:2) and maize + groundnut (2:4). During 2011-12, hand weeding (30DAS) (952 kg ha^{-1}) produced significantly higher baby corn yield than remaining weed management practices. PE application of pendimethalin 1 kg ha^{-1} (801 kg ha^{-1}) produced statistically similar baby corn yield as POE application of imazethapyr 50 g ha^{-1} (30 DAS) (778 kg ha^{-1}), both had significantly higher baby corn yield than weedy (684 kg ha^{-1}). During 2012-13, the maximum baby corn yield was obtained in PE application of pendimethalin 1 kg ha^{-1} (990 kg ha^{-1}) which was followed by hand weeding (30 DAS) (896 kg ha^{-1}), POE application of imazethapyr 50 g ha^{-1} (30 DAS) (780 kg ha^{-1}) and weedy check (387 kg ha^{-1}). All these treatments differed significantly from one another. On an average, hand weeding (30 DAS), PE application of pendimethalin 1 kg ha^{-1} and POE application of imazethapyr 50 g ha^{-1} (30 DAS) yielded 72.6, 67.2 and 45.5 per

cent higher baby corn yield over weedy check respectively. The higher baby corn yield in hand weeding (30 DAS) and herbicide treated plots were due to better growth and development of baby corn plants as a result of less competition from weeds for light, water, nutrients, carbon dioxide etc. as a result of better control of weeds as indicated by low weed density and weed dry weight. Presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and there by reduces sink capacity of crop resulting in poor yield. The efficiency of chemicals and other weed control practices in increasing grain yield had also been demonstrated by Dixit (1995), Shinde *et al.*, (2001), Khan *et al.*, (2002) and Khan and Haq (2004).

Stover yield of baby corn per hectare

The highest stover yield was found in baby corn sole (45 cm) which was followed by paired planting of maize (30/60 cm) + field pea (2:2) and planting of maize + field pea (1:1) during 2011-12 (Table 7). All these treatments differed significantly from one another. During 2012 -13, baby corn sole (45 cm) had significantly higher stover yield than paired planting of maize (30/60 cm) + field pea (2:2) and planting of maize + field pea (1:1). The difference between paired planting of maize (30/60 cm) + field pea (2:2) and planting of maize + field pea (1:1) was non-significant. On an average, sole planting of baby corn yielded 123.1 and 97.3 per cent more stover yield over planting of maize + field pea (1:1) and paired planting of maize (30/60 cm) + field pea (2:2) respectively. This was mainly due to better growth and dry matter accumulation in sole planting of baby corn. Similar results were reported by Mandalet *al.*, (2014_a) who reported that sole maize produced significantly higher stover yield than all other intercropping treatments with groundnut. Among the weed

management practices, PE application of pendimethalin 1 kg ha⁻¹ had statistically similar stover yield as hand weeding (30 DAS), both had significantly higher stover yield than POE application of imazethapyr 50 g ha⁻¹ (30 DAS) and weedy check during both the years. On an average, hand weeding (30 DAS), pre emergence application of pendimethalin 1 kg ha⁻¹ and post emergence application of imazethapyr 50 g ha⁻¹ (30 DAS) yielded 33.3, 39.2 and 3.5 per cent higher stover yield over weedy check respectively. More stover yield in weed control treatments than weedy check was due to less weed density and better growth and development of baby corn plants, which resulted in more biomass of baby corn plants. These results are in close agreement with Sinhaet *al.*, (2001), Dixit and Gautam (1996) and Shindeet *al.*, (2001) who found that use of herbicides to control weeds resulted in increased plant height, plant population and stover yield.

Field pea equivalent yield

The highest field pea equivalent yield was recorded in paired planting of maize (30/60 cm) + field pea (2:2) which was followed by planting of maize + field pea (1:1), field pea sole (30 cm) and baby corn sole (45 cm) during 2011-12. All these treatments differed significantly from one another. During 2012 - 13, planting of maize + field pea (1:1) had statistically similar field pea equivalent yield as paired planting of maize (30/60 cm) + field pea (2:2), both had significantly higher field pea equivalent yield than sole planting of field pea (30 cm) and baby corn (45 cm). Higher field pea equivalent yield in case of intercropping than that of sole planting was mainly due to additional advantage of intercrops yield and higher economic values of intercrops. Similar results were also obtained by Kheroar and Patra (2014) who obtained higher maize grain equivalent yield in all the cases of intercropping of maize with green

gram, black gram, soybean, groundnut and red gram than sole maize. Hand weeding (30 DAS) had significantly higher field pea equivalent yield than remaining weed management practices during 2011-12. The difference between PE application of pendimethalin 1 kg ha⁻¹ and POE application of imazethapyr 50 g ha⁻¹ (30 DAS) was non-significant, both had significantly higher field pea equivalent yield than weedy check. During 2012-13, PE application of pendimethalin 1 kg ha⁻¹ had statistically similar field pea equivalent yield as hand weeding (30 DAS), both recorded significantly higher field pea equivalent yield than POE application of imazethapyr 50 g ha⁻¹ (30 DAS) and weedy check. POE application of imazethapyr 50 g ha⁻¹ (30 DAS) computed significantly higher field pea equivalent yield than weedy check. In the light of the two years experimental results, it may be concluded that paired planting of maize (30/60 cm) + field pea (2:2) has been found more remunerative and efficient in terms of yield advantage (field pea equivalent yield) and weed control than planting of maize + field pea (1:1) and sole planting. Hand weeding at 30 DAS proved more beneficial compared to PE application of pendimethalin 1 kg ha⁻¹, POE application of imazethapyr 50 g ha⁻¹ (30 DAS) and weedy check.

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