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Planting pattern and weed control measure on yield and profitability of Maize (*Zea mays*)+Urdbean (*Vigna mungo*)intercropping in Himalayan *tarai*

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ABSTRACT

A field study was conducted at Norman E. Borlaug, Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar to establish suitable planting techniques and weed control practices for getting higher yield and profitability of maize+urdbean intercropping system.Urdbean pure recorded lesser total weed density and dry weight followed by paired rows maize (30/90cm)+urdbean (2:2). Maize sole and maize + urdbean (1:1) recorded higher weed density and weed dry weight. Weed control efficiency (60.5%) was high in paired rows of maize (30/90cm)+urdbean (2:2) compared to sole planting of maize and urdbean. Sole planting of urdbean and maize recorded higher values of yield attributes and yield than. maize+urdbean (1:1) and paired rows planting of maize (30/90cm) +urdbean significantly produced higher urdbean equivalent yield and land equivalent ratio than sole either urdbean or maize. Lower weed density and weed dry weight was recorded in weed free followed by pendimethalin 1.0 kg ha^{-1}+ hand weeding (25 days after sowing). Highest net return (¹ 46621 ha^{-1}) and benefit: cost ratio (1.83) was under maize (60 cm) +urdbean (1:1) followed by maize (30/90 cm) +urdbean (2:2). Amongst the weed control practices weed free calculated maximum values of gross return, net return and benefit : cost ratio (2.22) followed by pendimethalin 0.75 kg ha^{-1}(Pre-emergence) + hand weeding (25 days after sowing) (1.88).

Keywords: Economics, equivalent yield, intercropping, land equivalent ratio, maize, urdbean.

Cereals and pulses constitute a major portion of food basket of India.The country is targeting 300 million tonnes food grain production for 2025. The availability of cultivable land is decreasing and high vertical growth in crop production would be required to feed the growing population. Growing of food crops continuously creates specialised farming system which ismore favourable to high risk of biotic and abiotic pressure. Land use efficiency is also reduced under sole cropping as compared to intercropping (Kour *et al.*, 2015). Intercropping is mainly practiced by small and marginal farmers with a view to increase land use efficiency by growing diversified crops in a cropping system. Intercropping of cereal and legume not only helps in diversification of system but also enriches soil fertility and makes the production system profitable. Maize+urdbean is a popular intercropping system in humid tropical regions. Maize is planted at wider spacing which provides good chance to grow urdbean a short statured having differential requirement for growth parameters. Plant geometry plays a major role in making intercropping system sustainable. Variable space available under different plant geometry system leads to varying degree of competition which may have positive or negative interaction between component crops.

Weed infestation is major problem in widely spaced crops of *kharif* season. Production potential of any cropping system depends on weed infestation and their management.Weeds account to an average of 30-50% yield loss in maize + urdbean system (Mishra, 1997).Weed management in intercropping system may differ owing to shift in weed species and critical crop weed competition period. Intercropping itself is one of the suitable options of limiting weed infestation. Intercropping requires a different strategy of weed management in terms of cultural and chemical parameters as it is one of the essential components of integrated weed management. Keeping all above points into consideration a field study was conducted to find out impact of planting technique and weed control options on growth parameters, yield and economics of maize+urdbean intercropping system.

MATERIALS AND METHODS

Field experiment was conducted during *kharif* seasons of 2013 and 2014 at Dr. Norman E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar Uttarakhand. The station is situated at 29° N latitude, 79.3° longitude.The altitude of experimental area was 243.84 m above mean sea level lies in *tarai* belt of Shivalik range of Himalayan foothills. Humid sub-tropical with hot summer and cold winter are the climatic characters of this area. South-west, monsoon starts in the last week of June and remains up to September.

Meteorological data were recorded from the University meteorological observatory. The maximum and minimum temperature ranged between 30.2-33.6°C and 26.9-34.2°C, and 16.8-26.3°C and 15.5-26.3°C, respectively during the period of study. The rainfall of

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1013.04 mm and 569.8 mm were recorded for 2013 and 2014, respectively.The soil characteristics were 'Mollisols' soil order, sandy loam texture with high carbon contents 0.77% and 0.87% during experimental seasons respectively. Low available nitrogen 188.0 and 204.0 kg ha^{-1}, medium in available phosphorus 16.9 and 17.3 kg ha^{-1} and potassium contents 185.3 and 187.0 kg ha^{-1} were the fertility levels with soil pH 7.1 and 7.3 at the time of sowing during 2013 and 2014, respectively. The study was conducted in split plot design with three replications.Twenty treatments combinations of4 planting patterns[*viz*; urdbean sole (30 cm), maize sole (60 cm) normal planting of maize+urdbean (1:1) and paired row planting of maize+urdbean (30/90 cm)]in main plots and in sub plots were weed management practices i.e. weedy check, weed free, pendemethalin 0.75 kg ha^{-1} as pre-emergence (PE)+ one hand weeding (HW) at 25 days after sowing (DAS), imazethapyr 75g ha^{-1} at 20 DAS and pendimethalin 0.75 kg ha^{-1}(PE)+ imazethapyr 75 g ha^{-1} at 20 DAS allotted randomly in experimental unit. In first year crops were sown on 22.08.2013 and in second year on 26.07.2014 using standard agronomic practices. Maize was fertilised using recommended dose of fertilisers (120, 60 and 40 kg N: P_2O_5: K_2O per hectare) for irrigated condition of maize in this area. At the time of sowing half of nitrogen and full dose of phosphorus and potash were applied remaining half of nitrogen was applied at 30-35 DAS of maize crop during both the years. For urdbean 18:48:24kg per hectare N: P_2O_5: K_2O, respectively were used through 150 kg ha^{-1} of NPK mixture (12:32:16) at the time of planting. No extra dose of fertilisers was given to urdbean. Sowing of maize was donein line at 60 cm apart and urdbean was sown at 30 cm apart placing seeds at 5 cm depth during study. In maize+urdbean (1:1) intercropping maize row was alternated with urdbean row and for paired row planting of maize+urdbean (2:2) 2 rows of urdbean were sown in between 2 paired rows of maize. Sole urdbean was sown using 15 kg seeds and sole maize was sown using 20 kg seedsper hectare. Maize variety 'Surya' and urdbean variety 'Pant urd-31' were used for sowing during both the years. After sowing of both the crops, seeds were covered properly. To obtain optimum plant stand per unit area of each crop,thining was done at 15 DAS to obtained proper plant geometry. Plant to plant distance 10 cm for urdbean and 20 cm for maize were kept for proper growth and developments of the crops. Manual weeding was done in weed free treatment plots and pendimethalin 0.75 kg ha^{-1}+one HW treatment plots at 25 days after sowing using *khurpi*. Herbicides were sprayed using 500 litres through knapsack sprayer fitted with flat fan nozzle.Urdbean harvested from the net plot manually at the stage when > 80 per cent pods in all urdbean plants become dark brown in colour. Harvested crop was left in same plot for sun drying for three to four days. Threshing through beating was done by wooden stick. Winnowing was done to separate the grains from husk and grain yield was quantified and expressed at 10 per cent moisture in grain. Harvesting of maize was done when the cob's silk showed brown yellow color and cobs totally dried. The cobs were separated from stalks manually and stalks were from the ground with the help of sickle. Cobs were peeled out and left in open area for 3-4 days for sun drying. After drying maize sheller was used to separate the grains from the cobs. Grain yield of maize was reported at 12 per cent moisture.Observations on both the crops were recorded using standard procedure and data were analysed using split plot design ANOVA technique suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSION

Effect on weeds

Planting pattern and weed management measures significantly affected the weed density (Table 1). The lowest weed density was observed with urdbean sole planting while higher weed density was recorded in maize + urdbean (1 : 1) which was on parto maize sole planting but significantly higher than maize + urdbean (2 : 2). Among the weed control measures, weedy check counted significantly higher weed density than other weed control treatments.The lowest weed density was in weed free. Imazethapyr 75g ha^{-1} at 20 DAS and pendimethalin 0.75 kg ha^{-1} pre-emergence + imazethapyr 75g ha^{-1} at 20 DAS recorded on par weed density but it was significantly lower than weedy. Lowest weed density was with pendimethalin 0.75 kg ha^{-1} + 1 HW (25 DAS) during study periods.

Weed dry weight and weed control efficiency were not affected by planting patterns but weed control measures significantly affected these two parameters. Highest weed dry weight was recorded in weedy check. Pendimethalin0.75 kg ha^{-1} pre emergence + 1HW (25 DAS) produced significantly lesser weed dry weight than other weed control practices which was followed by pendimethalin 0.75 kg ha^{-1} pre emergence + imazethapyr75g ha^{-1} at 20 DAS.The maximum weed control efficiency was with weed free followed by pendimethalin 0.75 kg ha^{-1} (PE) + 1HW (25 DAS). Lower weed density in herbicidal treatments over weedy check was because of suppresive effect of herbicide on weed growth. The findings are in accordance with the results reported byYounesabadi *et al.(*2013).

Growth, yield attributes and yield of urdbean

Planting pattern did not influence the pods per plant, pod length, trifoliate leaves per plant and root nodules per plant during both the years of study.Grains per pod, grain weight per plant were significantly influenced by the treatments during 2014. Grain yield and harvest index were significantly influenced by planting pattern

Table 1: Influence of planting patterns and weed control practices on weed density, weed dry weight and weed control efficiency under maize + urdbean intercropping during 2013 and 2014

Treatment	Weed density m^{-2}		Weed dry weight ($g\ m^{-2}$)		Weed control efficiency (%)	
	2013	2014	2013	2014	2013	2014
Planting pattern						
Urdbean sole (30 cm)	114.30 (9.51)	138.4 (10.44)	68.52 (7.24)	79.9 (7.9)	58.0	59.1
Maize sole (60 cm)	124.00 (9.88)	149.93 (10.83)	70.68 (7.35)	80.20 (8.0)	59.0	59.7
Maize (60 cm) +Urdbean (1: 1)	124.10 (9.94)	149.93 (10.83)	69.95 (7.30)	80.3 (7.9)	58.3	58.8
Paired Maize (30/90cm) + Urdbean (2: 2)	119.80 (9.79)	145.2 (10.74)	67.69 (7.18)	78.4 (7.8)	59.7	60.5
SEm(±)	**1.12 (0.04)**	**1.43 (0.05)**	**1.04 (0.09)**	**1.17 (0.014)**	**0.4**	**0.4**
LSD (0.05)	**3.89 (0.16)**	**4.96 (0.18)**	**NS**	**NS**	**NS**	**NS**
Weed control measures						
Weedy check	277.20 (16.67)	335.0 (18.30)	167.8 (12.8)	198.4 (14.1)	00	00
Weed free	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	100	100
Pendimethalin0.75kg ha^{-1}(PE) + 1 HW(25DAS)	80.30 (9.00)	97.16 (9.89)	43.03 (6.38)	47.8 (6.9)	74.3	75.8
Imazethapyr 75g ha^{-1} (20DAS,POE)	122.90 (11.11)	148.10 (12.21)	70.1 (8.3)	83.6 (9.1)	56.9	57.7
Pendimethalin 0.75kg ha^{-1}(PE) + imazethapyr 75g ha^{-1} (20DAS)	122.30 (11.10)	148.22 (12.21)	62.1 (7.7)	71.0 (8.4)	62.7	64.1
SEm(±)	**1.01 (0.04)**	**1.24 (0.04)**	**1.31 (0.05)**	**1.44 (0.02)**	**0.6**	**0.6**
LSD (0.05)	**2.92 (0.13)**	**3.59 (0.14)**	**3.78 (0.20)**	**4.15 (0.05)**	**1.9**	**1.8**

Figure in parenthesis are square root ($\sqrt{x+1}$) transformed values.

(Table 2). Pure planted urdbean recorded significantly higher grain yield over remaining patterns while maize + urdbean (1:1) andmaize+urdbean (2:2) produced on par urdbean yield. Higher yield with sole planting may be due to higher plant population of urdbean at harvest. Harvest index followed similar trend like grain yield. Amongst the weed control measures, weed free produced significantly more number of trifoliates, root nodules per plant, yield attributing characters and grain yield over remaining weed control practices except pendimethalin 0.75 kg ha^{-1}(PE) + one HW(25DAS) which yielded on par with weed free during 2014. Weedy plot produced lowest growth parameters, yield attributes, grain yield and harvest index of urdbean. Under weedy check grain yield reduction was 49.1and 41.9% during 2013 and 2014, respectively over weed free condition. Yield reduction in weedy plot may be due to higher number of weeds which caused more competition for resources as light, water and nutrient and eventually put more pressure on growth and survival of urdbean plants. Results are in accordance with findings reported by Poonam *et al.* (2013).

Growth, yield attributes and yield of maize

Planting pattern did not affect dry matter accumulation per plant, number of cobs per plant, grain rows per cob, grains per row, 100 grain weight and shelling percentage of maize while, grain yield and harvest index during 2014 was significantly influenced by planting patterns (Table 3). Maize sole planting recorded significantly highest maize grain yield than planning of maize + urdbean (1:1) but statistically on par with paired row planting of maize (30/90cm) + urdbean (2:2). Grain yield obtained in maize + urdbean (2:2) was higher but statistically on par with maize + urdbean (1:1) during both the years. This may be because of high growth parameters, yield attributing characters

Table 2: Influence of planting pattern and weed controlmeasure on growth, yield attributes and yield of urdbeanunder maize + urdbean intercropping during 2013 and 2014

Treatments	Pods per plant		Pod length (cm)		Grains per pod		Grain weight (g) per plant		Grain yield (Kg ha^{-1})		Harvest index		Root nodules per plant		Number of trifoliates	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Planting pattern																
Urdbean sole (30 cm)	26.8	33.3	3.1	3.9	4.7	5.9	4.6	5.7	500	861	33.12	34.74	25.40	31.80	17.6	22.9
Maize sole (60cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maize (60 cm)+ Urdbean (1 : 1)	25.5	31.6	2.9	3.7	4.6	5.7	4.5	5.6	407	479	32.10	28.37	24.20	30.16	18.1	23.3
Paired Maize (30/90 cm) + Urdbean (2 : 2)	25.2	31.4	3.0	3.8	4.5	5.6	4.4	5.4	434	542	31.88	31.57	23.80	29.79	17.8	22.7
SEm(±)	**0.6**	**0.5**	**0.1**	**0.1**	**0.1**	**0.04**	**0.1**	**0.04**	**8.80**	**31.00**	**0.10**	**0.44**	**0.73**	**0.89**	**0.4**	**0.3**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**0.15**	**NS**	**0.16**	**35**	**120**	**0.40**	**1.72**	**NS**	**NS**	**NS**	**NS**
Weed control measures																
Weedy check	19.3	23.8	2.7	3.4	4.3	5.4	2.8	3.5	298	434	31.88	30.65	14.94	18.62	14.8	18.5
Weed free	29.7	36.7	3.3	4.1	4.8	6.0	5.3	6.6	586	747	32.67	29.16	28.80	35.96	18.9	25.4
Pendimethalin0.75kg ha^{-1}(PE) + 1 HW(25DAS)	28.9	35.8	3.2	4.0	4.7	5.8	5.8	7.2	551	775	32.59	33.89	28.03	35.33	19.9	25.2
Imazethapyr 75 g ha^{-1}(20DAS)	22.4	27.9	2.7	3.4	4.5	5.5	3.5	4.3	358	590	32.31	33.03	26.30	32.55	17.6	22.8
Pendimethalin 0.75kg ha^{-1}(PE) + Imazethapyr75 g ha^{-1}(20DAS)	28.8	36.3	3.2	4.0	4.8	6.0	5.1	6.3	441	590	32.36	31.08	24.26	30.45	18.0	22.9
SEm(±)	**0.7**	**0.5**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.13**	**10.31**	**30.00**	**0.21**	**0.73**	**0.64**	**0.71**	**0.4**	**0.6**
LSD (0.05)	**2.02**	**1.5**	**0.2**	**0.2**	**0.3**	**0.3**	**0.4**	**0.39**	**30.33**	**87.00**	**0.62**	**2.15**	**1.80**	**2.07**	**1.4**	**1.9**

Table 3 : Influence of planting pattern and weed control measure on growth, yield attributes and yield of maizeunder maize + urdbean intercropping during 2013 and 2014

Treatment	Dry matter accumulation (g per plant) at harvest		Cobs per plant		Grains rows per cob		Grains per row		100 grains weight (g)		Shelling (%)		Grain yield (Kg ha^{-1})		Harvest index (%)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Planting pattern																
Urdbean sole (30 cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maize sole (60 cm)	113.0	140.3	1.02	1.28	11.0	13.6	23.0	28.7	16.8	21.0	77.6	82.8	2461	3271	35.94	36.88
Maize (60 cm) + Urdbean (1 : 1)	112.2	140.3	1.07	1.34	11.1	13.9	22.6	28.1	16.4	20.5	76.2	81.3	2300	2472	35.69	36.61
Paired Maize (30/90cm) + Urdbean (2 : 2)	114.6	142.7	1.06	1.33	11.0	13.7	22.8	28.4	16.5	20.5	76.6	81.8	2396	2885	36.28	38.35
SEm(±)	**2.9**	**3.9**	**0.04**	**0.04**	**0.2**	**0.2**	**0.6**	**0.8**	**0.3**	**0.3**	**0.4**	**0.75**	**26**	**111**	**0.44**	**0.30**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**104**	**429**	**NS**	**1.2**
Weed control measures																
Weedy check	106.4	132.2	0.94	1.17	10.3	13.0	22.6	29.9	16.7	20.8	73.1	78.0	1435	2321	26.60	34.57
Weed free	125.2	155.7	1.14	1.49	11.8	14.7	23.2	29.4	17.0	21.1	80.3	85.6	3565	3588	37.68	38.48
Pendimethalin0.75kg ha^{-1}(PE) + 1 HW(25DAS)	117.7	147.6	1.14	1.44	11.8	14.7	23.3	28.9	16.6	20.8	80.4	85.8	3061	3403	36.75	38.33
Imazethapyr 75g ha^{-1}(20DAS)	108.2	134.9	0.98	1.22	10.1	12.6	22.2	27.6	16.2	20.2	75.0	80.0	1513	2344	33.86	36.12
Pendimethalin 0.75 kg ha^{-1}(PE) + imazethapyr 75 g ha^{-1}(20DAS)	108.8	135.5	1.06	1.33	11.0	13.8	22.6	28.3	16.4	20.6	75.3	80.4	2354	2766	32.77	38.02
SEm(±)	**2.8**	**1.3**	**0.05**	**0.05**	**0.2**	**0.3**	**0.3**	**0.8**	**0.4**	**0.4**	**0.5**	**1.1**	**26**	**173**	**0.62**	**0.57**
LSD (0.05)	**8.2**	**9.9**	**0.25**	**0.16**	**0.8**	**0.9**	**NS**	**NS**	**NS**	**NS**	**1.5**	**3.2**	**76**	**505**	**1.81**	**1.60**

Table 4 : Influence of planting pattern and weed control measure on urdbean equivalent yield (UEY), Land Equivalent Ratio (LER) and economicsof maize + urdbean intercropping.

Treatments	Urdbean equivalent yield (Kg ha^{-1})		LER		Net return (^{1} ha^{-1}) (Averaged of 2years)	B:C ratio (Averaged of 2years)
	2013	2014	2013	2014		
Planting pattern						
Urdbean sole (30 cm)	500	861	1.00	1.00	21588	1.22
Maize sole (60 cm)	722	985	1.00	1.00	32713	1.51
Maize (60 cm) + Urdbean (1 : 1)	1099	1348	1.87	1.49	46621	1.83
Paired Maize (30/90 cm) + Urdbean (2 : 2)	1176	1286	1.96	1.24	44716	1.76
SEm(±)	**11**	**25**	**0.03**	**0.04**	**-**	**-**
LSD (0.05)	**42**	**99**	**0.12**	**0.15**	**-**	**-**
Weed control measures						
Weedy check	921	924	1.57	1.38	23584	1.15
Weed free	1413	1491	1.31	1.19	51799	2.22
Pendimethalin 0.75kg ha^{-1}(PE) + 1 HW(25DAS)	1247	1395	1.45	1.08	46308	1.88
Imazethapyr 75 g ha^{-1}(20DAS,POE)	679	1030	1.52	1.23	27521	1.27
Pendimethalin 0.75 kg ha^{-1}(PE) + imazethapyrg ha^{-1}(20DAS)	734	1191	1.41	1.34	32822	1.45
SEm(±)	**16**	**51**	**0.08**	**0.08**	**-**	**-**
LSD (0.05)	**47**	**148**	**NS**	**NS**	**-**	**-**

in maize sole planting which resulted higher grain yield of maize. Paired row planting performed better over normal planting which may be due to better light interception and minimization of inter-specific competition helped the better growth and development of plants.

Weed control measures affected the growth, all yield attributing characters significantly, except grains per row and 100 grain weight and yield of maize during 2013 and 2014. Weed free practice on par with pendimethalin 0.75kg ha^{-1}(PE) + oneHW(25DAS), measured significantly higher growth, yield attributes, harvest index and grain yield during 2014 compared to remaining treatments.

Maize grown under weed free condition produced the highest grain yield per hectare followed by pendimethalin 0.75 kg ha^{-1}(PE) +oneHW (25DAS) and pendimethalin 0.75kg ha^{-1}(PE) + imazethapyr 75 g ha^{-1}(20DAS). Moreover, grain yield under pendimethalin 0.75 kg ha^{-1} (PE)+one HW (25DAS) was statistically higher than pendimethalin 0.75 kg ha^{-1}(PE) + imazethapyr 75 g ha^{-1} (20DAS) and application of imazethapyr 75 g ha^{-1}(20 DAS) alone. In 2014, pendimethalin 0.75kg ha^{-1}(PE) +one HW (25DAS) being statistically on parwith weed free treatment recorded significantly higher grain yield of maize over application of pendimethalin 0.75kg ha^{-1}(PE) + imazethapyr 75 g ha^{-1}(20DAS) and imazethapyr 75 g ha^{-1}(20 DAS) alone. Increase in grain yield under weed free condition over pendimethalin 0.75 kg ha^{-1}(PE) +one HW (25DAS), pendimethalin 0.75kg ha^{-1} (PE)+ imazethapyr 75 g ha^{-1}(20DAS) and imazethapyr 75 g ha^{-1} (20 DAS) alone, was 16.4,51.4 and 135.0 percent higher, respectively during 2013. However, during 2014 increase in grain yield under weed free over pendimethalin 0.75 kg ha^{-1}and +HW (25DAS), pendimethalin 0.75 kg ha^{-1} (PE)+ imazethapyr 75 g ha^{-1}(20DAS) and imazethapyr 75 g ha^{-1} (20 DAS) alone was 5.43,29.7 and 53.07 only. This may be because of higher plant population, more leaf area resulted in higher photosynthesis and more grain yield than other herbicidal treatments. Herbicidal effect on weeds, resulted better opportunity for the growth of maize and produced higher yield of maize. The results are in conformity with findings obtained by Sinha *et al.* (2001) and Shinde *et al.* (2001).

Sole maizebeing on par with maize + urdbean (1:1) produced lower harvest index than paired row planting of maize + urdbean (2:2). Paired row planting of maize + urdbean (2:2) recorded significantly higher harvest index compared to maize + urdbean (1:1) and sole planting pattern during 2014. Weed free treatment recorded significantly higher harvest index than weedy check but on par with pendimethalin 0.75 kg ha^{-1} (PE)+ one HW (25DAS) during study period. Lowest harvest index of maize was recorded in weedy check treatment during both the years.

Urdbean equivalent yield and Land equivalent ratio (LER)

Urdbean equivalent yield significantly influenced due to planting patterns and weed controlmeasures (Table 4). Urdbean equivalent yield obtained in paired planting of maize (30/90cm) + urdbean (2:2) was significantly superior to sole planting of maize and urdbean and maize + urdbean (1:1) during 2013 and on par during 2014.

During 2013, weed free condition computed significantly moreurdbean equivalent yield per hectare than other weed management practices. It was followed by pendimethalin 0.75 kg ha^{-1}(PE)+oneHW (25DAS) and pendimethalin 0.75kg ha^{-1}(PE)+ imazethapyr 75g ha^{-1}(20DAS). Moreover, urdbean equivalent yield under pendimethalin 0.75 kg ha^{-1}(PE)+ oneHW (25DAS) was significantly higher than pendimethalin 0.75 kg ha^{-1}(PE)+ imazethapyr 75 g ha^{-1}(20DAS) and imazethapyr 75 g ha^{-1} (20 DAS) alone. In 2014, pendimethalin 0.75 kg ha^{-1}+ oneHW (25DAS) being on par with weed free produced significantly higher urdbean equivalent yield than pendimethalin 0.75 kg ha^{-1}(PE)+ imazethapyr 75 g ha^{-1}(20DAS) and imazethapyr 75 g ha^{-1}(20 DAS) alone.

Land equivalent ratio (LER) varied due to planting patterns. Significantly higher LER was recorded in paired planting of maize (30/90 cm) + urdbean (2:2) over remaining pattern except maize + urdbean (1:1) where difference was non-significant during 2013. Moreover, maize + urdbean (1:1) planting pattern recorded statistically higher LER compared to remaining treatments during 2014.Similar results were also obtained in accordance with these results by Dwivedi *et al.,* 2015. Weed control measures did not differ significantly in terms of LER during study periods.

ECONOMICS

Cultivation cost varied due to various treatments (Table 4). The highest net return was recorded under maize + urdbean (1:1) (₹ 46621 ha^{-1}) followed by paired planting of maize (30/90 cm) + urdbean (2:2) (₹ 44716 ha^{-1}). Sole cropping of urdbeanrecorded the lowest among the treatments.

Various weed control measures also recorded the different net returns. In weed free net return was (₹ 51799 ha^{-1}) which was highest followed by pendimethalin 0.75kg ha^{-1} (PE)+oneHW (25DAS) (₹ 46308 ha^{-1}), pendimethalin 0.75 kg ha^{-1} + imazethapyr 75 g ha^{-1}(20 DAS) (₹ 32822 ha^{-1}), imazethapyr 75 g ha^{-1}(20 DAS) (^{1} 27521ha^{-1}) alone and weedy (₹ 21588 ha^{-1}). Highest benefit : cost ratio was computed in maize + urdbean (1:1) (1.83) followed by paired planting of maize (30/90 cm) + urdbean (2:2) (1.76),) and maize sole (60 cm) (1.51)and urdbean sole (30 cm) (1.22). Intercropping recorded higher net returns and B:C ratio because of more urdbean equivalent yield. Mandal *et al. (*2014) also reported similar results under cereal legume intercropping.

In case of weed control measures, weed free recorded the highest benefit:cost ratio (2.22) followed by pendimethalin 0.75kg ha^{-1}(PE)+oneHW (25DAS) (1.88), pendimethalin 0.75 kg ha^{-1}(PE) + imazethapyr 75 g ha^{-1} (20 DAS) (1.45), imazethapyr 75 g ha^{-1}(20DAS) alone (1.27) and weedy (1.15).

Two years of field study revealed that intercropping of maize + urdbean (1:1) and paired row of maize (30/ 60 cm) + urdbean (2:2) found more remunerative and efficient in terms of land utilisation, yield advantage and weed control than sole planting of maize orurdbean. To control the weeds under maize + urdbean intercropping application of pendimethalin 0.75 kg ha^{-1}(PE) followed by one hand weeding (HW) at 25 DAS proved more beneficial compared to rest of the treatments.

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