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Legume Intercropping for Weed Control Efficiency in *Kharif* Maize (*Zea mays* L.) under Amritsar Conditions

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ABSTRACT

Background: Maize is referred to as the "Queen of Cereals" since it has highest genetic yield potential. So, Maize being a rainy season crop, suffers badly due to heavy weed infestation reducing the potential yield. Intercropping with legumes is the effective technique to control weed infestation. Therefore, this study is focused on to evaluate the legume intercropping for weed control efficiency in *kharif* maize (*Zea mays* L.) under Amritsar conditions.

Methods: A field study was carried out to evaluate the effect of "Legume intercropping for weed control efficiency in *kharif* maize (*Zea mays* L.) under Amritsar conditions" at Student's Research Farm, P.G. Department of Agriculture, Khalsa College Amritsar, during *Kharif* season 2021-2022. The experiment consists of six treatment combination which were tested in factorial randomized block design with three replications. The treatment consisted of T_1 - sole maize, T_2- paired row maize, T_3- maize + green gram (1:1), T_4- maize + green gram (2:2), T_5- maize + black gram (1:1), T_6- maize + black gram (2:2) and two weed management practices *i.e.* weedy check and pendimethalin at 0.75 kg ha^{-1} (pre-emergence).

Result: The results indicated that maize + green gram (1:1) intercropping system registered considerably lowest weed density of both monocot and dicot weeds at 25 DAS (58.14 m^2) and 50 DAS (61.72 m^2) and also significantly lower weed dry matter at 25 DAS (2.06 q ha^{-1}), 50 DAS (4.58 q ha^{-1}), 75 DAS (5.88 q ha^{-1}). Maize + green gram (1:1) treatment also recorded considerably highest weed control efficiency (17.57 %) at 25 DAS and (16.38%) at 50 DAS. The highest maize grain yield (38.85 q ha^{-1}) was achieved in maize + green gram (1:1) followed by (37.68 q ha^{-1}) maize + black gram (1:1) and (33.41 q ha^{-1}) maize + green gram (2:2). Maize grain equivalent yield and benefit-cost ratio significantly superior in all the intercropping systems than pure stand yield of crop. The highest maize grain equivalent yield (66.78 q ha^{-1}) and benefits: cost ratio (3.6) was obtained in maize + green gram (2:2) followed by (3.31) maize + black gram (2:2) and (2.5) maize + green gram (1:1). Pre-emergence application of pendimethalin at 0.75 kg ha^{-1} gave substantially lower weed density at25 DAS (56.05 m^2), 50 DAS (57.97 m^2) and weed dry matter at 25 DAS (2.16 q ha^{-1}), 50 DAS (4.03 q ha^{-1}) and 75 DAS (5.35 q ha^{-1}) and significantly superior weed control efficiency at 25 DAS (30.97%) and 50 DAS (27.98 %) over weedy check. Significantly higher maize grain yield (36.94 q ha^{-1}), legumes yield (8.87 q ha^{-1}), maize grain equivalent yield (58.45 q ha^{-1}) and benefits: cost ratio (3.19).

Key words: Intercropping, Legumes, PE- Pre-emergence, WEC- Weed control efficiency.

INTRODUCTION

Maize is the foremost adaptable emerging crops, able to flourish in a variety of meteorological conditions. In the world, maize is implied as "Queen of Cereals" since it has ultimate genetic yield potential. Maize occupied area of 144.6 thousand hectares, with a production of 410.5 thousand tonnes in the Punjab State during 2019-20 (Anonymous 2021). The mean yield was 35.82 quintal per hectare, 14.50 quintal per acre (Anonymous, 2021). Because of the conditions during the rainy season that encourage the exuberant growth of weeds, maize crop suffers greatly from the start of sprouting. Widespread weed flora infests maize crops, resulting in yield losses that can vary from 34 to 67% and some times more (Kumar and Thakur, 2005). Despite, the fact that intercropping itself seems to have a lot of promise for improving crop dominance over weeds, the efficiency of weed management varies among various intercrops due to a number of factors affecting the intercrop-weed connection. Intercropping can suppress the weed growth more than the sole crops. Smallholder farmers find this practise to be an appealing method for boosting labour productivity and land usage through intensification of land uses (Seran and Brintha, 2010; Gitari *et al*., 2020). Intercropping legumes with cereals also improve the utilisation of available resources for maximum yield (Khonde *et al*., 2018).

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MATERIALS AND METHODS

The field experiment was under taken in *Kharif* season of year 2021 at the Students' Research Farm, P.G. Department

of Agriculture, Khalsa College Amritsar, Punjab, India. Amritsar is situated at 31.63°N latitude and 74.87°E longitude and has an elevation of 224.33m above sea level. The soil was sandy loam, pH (8.1), EC (0.36 ds m^{-1}), low organic carbon (42%) and available N, P and K was (179.1 kg ha^{-1}), (17.2 kg ha^{-1}), (259 kg ha^{-1}) respectively. Three replications of a factorial randomised block design were used to set up the experiment, twelve treatment combination in all, including six intercropping systems, *viz.* sole maize (single row), sole maize (paired row), maize + green gram (1:1), maize + green gram (2:2), maize + black gram (1:1), maize + black gram (2:2) and two weed management practice *viz.* weedy check and PE spray of pendimethalin 0.75 kg ha^{-1} were tested. A single row crop was seeded at a row space of 60 cm and 60/30 cm row spacing as sole maize (paired row). During the crop raising process, all the suggested cultural techniques, fertilizers and plant protection measures were implemented.

The numbers of weeds were counted from two spot selected randomly in each plot by using 0.25 m^2 quadrate and further weed dry matter and weed control efficiency were recorded as per the standard methods. Five randomly selected plants from each replication separately analysis for yield attributes at proper physiological maturity stage. The yield was recorded from net plot area of each treatment.

RESULTS AND DISCUSSION

Effect of intercropping system

Different intercropping systems have an impact on weed control efficiency (WCE), weed dry matter and weed control density displayed in Table 1. Intercropping systems considerably diminished the weed population and weed density than mono cropping single row and paired row. Significantly highest weed density (69.38 m^{-2} at 25 DAS and 73.06 m^{-2} at 50 DAS) and dry weight (2.91q ha^{-1} at 25 DAS, 6.21 q ha^{-1}at 50 DAS and 6.72 q ha^{-1} at 75 DAS) were recorded in maize (paired row) and significantly lowest weed density at 25 DAS (58.14 m^2) and 50 DAS (61.72 m^2) was recorded in maize + green gram (1:1) was followed by maize + black gram (1:1), maize + green gram (2:2). Among different intercropping systems, maize + green gram (1:1) recorded significantly lowest weed dry matter (2.06, 4.58 and 5.88 q ha^{-1} at 25, 50 and 75 DAS) and it was followed by maize + black gram (1:1). This was probably due to more shading effect of green gram canopy owing to a greater number of green gram plants per unit area (Dwivedi and Shrivastava, 2011). Similarly, the highest WCE was recorded under maize + green gram (1:1) intercropping system. This could be probably due to more shading effect of mungbean canopy owing to more number of green gram plants per unit area. These findings are similar with Dwivedi and Shrivastava (2011).

Yield and yield attributes of maize

Table 2 demonstrated that maize + green gram (1:1) produced significantly higher numbers of cobs $plant^{-1}$ (1.13), cob length (14.0 cm) and 1000 grain weight (240 g) in comparison to rest of intercropping systems and mono cropping systems. This was due to the development of both temporal and spatial complementarity as a result of which there was no competition for nitrogen and there was possibility of current transfer of fixed nitrogen to the cereals crops like maize, Kheror and Patra (2014) reported similar results.

When planted with a 60 cm row spacing, maize always produced more grain than when planted in paired rows. Legumes like green gram and black gram were intercropped with maize to boost grain yield. Table 2 depicted that maize + green gram (1:1) considerably higher grain yield (38.85 q ha^{-1}), stover yield (66.85 q ha^{-1}), biological yield (105.7 q ha^{-1}) followed by maize + black gram (1:1) and maize + green gram (2:2). This was probably occurred from the difference in the timing utilization of resources by the different crops from different soil layers, especially during peak vegetative and reproductive

Table 1: Effect of intercropping and weed management on weed density, weed dry matter and weed control efficiency.

Treatments	Weed density 25 DAS (no. m^{-2})			Weed density 50 DAS (no. m^{-2})			Weed dry matter (q ha^{-1})			Weed control efficiency (%)	
	Monocot	Dicot	Total	Monocot	Dicot	Total	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS
Factor A											
T_1- Sole maize	39.50	27.06	66.38	41.55	29.06	70.61	2.70	5.60	6.58	14.55	12.01
T_2- Paired row maize	41.33	28.05	69.57	43.03	30.02	73.06	2.91	6.21	6.72	13.58	11.94
T_3- Maize + Green gram (1:1)	36.06	22.08	58.14	37.55	24.16	61.72	2.06	4.58	5.88	17.57	16.38
T_4- Maize + Green gram (2:2)	38.35	24.07	62.42	39.56	25.9	65.46	2.61	5.08	6.11	16.01	15.03
T_5- Maize + Black gram (1:1)	37.52	23.10	60.62	39.04	25.07	64.12	2.58	4.70	5.91	16.03	15.05
T_6- Maize + Black gram (2:2)	38.50	25.58	64.08	40.52	27.54	68.06	2.66	5.45	6.23	15.14	13.52
CD (0.05)	2.95	2.65	5.48	2.94	2.58	5.41	0.40	0.56	0.60	-	-
Factor B											
Weedy check	44.11	26.91	71.03	46.5	29.87	76.37	3.01	6.51	7.13	0	0
Pendimethalin at 0.75 kg ha^{-1} as PE	32.98	23.06	56.05	33.92	24.05	57.97	2.16	4.03	5.35	30.97	27.98
CD (0.05)	1.70	1.53	3.16	1.70	1.49	3.12	0.23	0.32	0.34	-	-

stages of growth thus resulting in both temporal and spatial complementarities, Kheror and Patra (2014). Also, it might be resulted from maize-legumes association due to symbiotic nitrogen fixation by legumes. Reading is in line with Rana *et al*. (2001), Parimaladevi *et al*. (2019).

Yield and yield attributes of intercrop

Yield of intercrop was affected due to different row proportions (1:1 and 2:2) intercropping system. Maize + green gram (2:2) reported significantly higher pods plant^{-1} (23.0), seed pod^{-1} (9.18), 1000 grain weight (31.66 g) and grain yield (8.57 q ha^{-1}), haulm yield (28.00 q ha^{-1}), biological yield (36.58 q ha^{-1}) was followed by maize + black gram (2:2), maize + green gram (1:1) respectively (Table 3). Due to receiving more sun radiation, yield was marginally higher at a 2:2 sowing ratio than at a 1:1 ratio. The leguminous crops were shadowed by the tall maize plants, which likely contributed to the production decline by receiving less solar radiation, which slowed down photosynthesis and altered the movement of photosynthates from source to sink. Results were similar with Parimaladevi *et al*. (2019).

Maize grainequivalent yield and benifits: cost ratio

Table 4 shows that the higher maize grain equivalent yield and benefit-cost ratio was seen in all the intercropping system compared to pure maize yield. Ankushdeep and Kumar (2022); Panda *et al*. (2021) additionally stated comparable observations in distinctive intercropping systems. The higher maize grain equivalent yield (66.78 q ha^{-1}) and B-C ratio (3.6) was noted in maize + green gram (2:2) intercropping due to higher yield and price of green gram followed by maize + black gram (2:2), maize + green gram (1:1) respectively, Naher *et al*. (2020).

Effect of weed management

Table 1 show that weed management with pendimethalin at 0.75 kg ha^{-1} had weed density (56.05 m^{-2}) at 25 DAS and (57.97 m^{-2}) at 50 DAS which was significantly lower over

Table 2: Effect of weed management and intercropping on yield attributes and yield of maize.

Treatments	Yield attributes of maize			Maize yield			Harvest index (%)
	Cob length (cm)	Cobs plant^{-1} (no.)	1000 grain weight (g)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	
Factor A							
T_1- Sole maize	12.6	0.93	237.0	34.84	59.74	94.65	36.77
T_2- Paired row maize	12.55	0.90	234.16	34.21	59.21	93.43	36.75
T_3- Maize + Green gram (1:1)	14.5	1.13	240.0	38.85	66.85	105.7	36.97
T_4- Maize + Green gram (2:2)	12.05	0.86	231.0	33.41	58.10	91.51	36.58
T_5- Maize + Black gram (1:1)	13.08	1.10	239.66	37.68	64.33	102.01	36.78
T_6- Maize + Black gram (2:2)	11.51	0.83	230.5	32.23	57.08	90.32	36.51
CD (0.05)	1.72	0.15	7.19	3.03	5.16	6.75	NS
Factor B							
Weedy check	12.05	0.85	225.16	33.80	59.27	93.09	36.30
Pendimethalin at 0.75 kg ha^{-1} as PE	13.38	1.06	245.61	36.94	62.50	99.45	37.16
CD (0.05)	0.99	0.09	4.15	1.75	2.98	3.90	NS

Table 3: Effect of weed management and intercropping on yield attributes and yield of intercrops.

Treatments	Yield attributes of intercrop			Yield of intercrop			Harvest index (%)
	Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	1000 grain weight (g)	Seed yield (q ha^{-1})	Haulm yield (q ha^{-1})	Biological yield (q ha^{-1})	
Factor A							
T_1- Sole maize	-	-	-	-	-	-	-
T_2- Paired row maize	-	-	-	-	-	-	-
T_3- Maize + Green gram (1:1)	18.66	9.05	29.05	6.89	25.0	31.89	21.60
T_4- Maize + Green gram (2:2)	23.0	9.18	31.66	8.57	28.00	36.58	23.28
T_5- Maize + Black gram (1:1)	17.33	4.53	27.05	6.59	23.83	30.43	21.41
T_6- Maize + Black gram (2:2)	20.66	5.08	31.16	7.94	26.50	34.44	22.79
CD (0.05)	2.1	1.1	2.2	0.91	2.45	2.79	NS
Factor B							
Weedy check	18.75	6.03	27.71	6.13	24.75	30.88	19.78
Pendimethalin at 0.75 kg ha^{-1} as PE	21.08	7.89	31.75	8.87	26.91	35.79	24.76
CD (0.05)	1.8	0.8	1.6	0.64	1.73	1.97	1.69

Table 4: Effect of weed management and intercropping on maize grain equivalent yield and benefit-cost ratio.

Treatments	MEY (q ha^{-1})	B:C
Factor A		
T_1- Sole maize	34.84	1.96
T_2- Paired row maize	34.21	1.80
T_3- Maize + Green gram (1:1)	59.98	2.5
T_4- Maize + Green gram (2:2)	66.78	3.60
T_5- Maize + Black gram (1:1)	59.94	2.38
T_6- Maize + Black gram (2:2)	65.65	3.31
CD (0.05)	4.11	0.39
Factor B		
Weedy check	48.68	1.99
Pendimethalin at 0.75 kg ha^{-1} as PE	58.45	3.19
CD (0.05)	2.37	0.22

weedy check (71.03 m^{-2}) at 25 DAS and (76.37 m^{-2}) at 50 DAS. This treatment also gave significantly lower weed dry matter at 25 DAS (2.1 q ha^{-1}), 50 DAS (4.03 q ha^{-1}) and 75 DAS (5.35 q ha^{-1}) over weedy check (3.01 q ha^{-1}) at 25 DAS, (6.51 q ha^{-1}) at 50 DAS, (7.13 q ha^{-1}) at 75 DAS. Additionally, PE spray of pendimethalin (0.75 kg ha^{-1}) demonstrated greater weed control efficiency (30.97%) at 25 DAS, (27.98%) 50 DAS. Ali *et al*. (2014) also noted that due to weed mortality from weed control practices, pendimethalin treated plots had a significant reduction in weeds density when compared to weedy check plots.

Pendimethalin at 0.75 kg ha^{-1} as PE considerably increased number of cobs plant^{-1}(1.06), cob length (13.85 cm),1000 grain weight (245.61g), grain yield (36.94 q ha^{-1}), stover yield (62.50 q ha^{-1}), biological yield (99.45 q ha^{-1}) respectively, over weedy check *i.e.* cobs plant^{-1} (0.85), cob length (12.05 cm), 1000 grain weight (225.16 g), grain yield (33.80 q ha^{-1}), stover yield (59.27 q ha^{-1}), biological yield (93.09 q ha^{-1}). Jadhav *et al*., (2014) also stated same results. Also significantly increased number of seeds pod^{-1} (7.89), pods plant^{-1} (21.08), 1000 grain weight (31.75g), seed yield (8.87 q ha^{-1}), haulm yield (26.91 q ha^{-1}), biological yield (35.79 q ha^{-1}), respectively over weedy check. (Ehsas *et al*., 2016). Pendimethalin at 0.75 kg ha^{-1} as PE also significantly higher maize grain equivalent yield (58.45 q ha^{-1}) and benefit-cost ratio (3.19) over weedy check. (Naher *et al*., 2020).

CONCLUSION

The present investigation revealed that among different treatment combination, maize + green gram (1:1) proved considerably lower weed densities and weed dry matter and considerably higher weed control efficiencies compared to all other treatments. Maize crop yield attributes and yield was also Recorded significantly higher in maize + green gram (1:1) compared to all other treatments. But higher maize equivalent yield and B:C were registered in maize + green gram (2:2).

Conflict of interest: None.

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