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Influence of Mulching and Weed Management Practices on Weeds and Nutrient Uptake in Greengram (*Vigna rediata* L.) under Eight Year Old Custard Apple Plantation

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Abstract

An experiment was conducted at Agronomy Research Station, Barkacha, Mirjapur 201–14 to assess the effect of mulching and weed management practices on weeds and nutrients uptake by greengram under agri-horti system. Three mulch treatments were taken in main plot (no-mulching, dust-mulching and paddy straw-mulching) and five weed control treatments (weedy check, weed free, pendimethalin pre-emergence (PE) 1000 g ha^{-1}, imazethapyr post-emergence (PoE) 100 g ha^{-1} and pendimethalin (PE) 1000 g ha^{-1} followed by (*fb*) imazethapyr (PoE) 100 g ha^{-1}) was randomly allocated to subplots and these were replicated thrice in split plot design. The results revealed that dust mulching recorded lowest density and dry weight of weeds, N, P, K depletion by weeds and resulted significantly the highest growth parameters (pant height, crop dry weight and branches $palnt^{-1}$), N, P, K content and their uptake by crop, grain and straw yield, gross and net returns of greengram over paddy straw mulching and no-mulching, respectively. Pre-emergence application of pendimethalin (1000 g ha^{-1}) *fb* post-emergence application of imazethapyr (100 g ha^{-1}) recorded lowest density and dry weight of weeds, N, P, K depletion by weeds and recorded the highest growth parameters, grain and straw yield, N, P, K contents and their uptake, gross and net returns by crop as compared to alone application of pendimethalin (PE) 1000 g ha^{-1} and imazethapyr (PoE) 100 g ha^{-1}, respectively. However, no mulching recorded maximum B: C ratio in among the mulches and among weed management practices alone application of pendimethalin recorded maximum B:C ratio.

Keywords: Herbicides, mulching, nutrient content, nutrients uptake, weed, yield

1. Introduction

Greengram (*Vigna radiata* L.) is one of the most widely cultivated pulse crops in the country and is grown on about 3.44 mha with the annual production of 1.78 mt along with the productivity of 499 kg ha^{-1} (DES, 2013). Greengram grown in different seasons and cropping systems due to its wider adoptability and less sensitivity to photoperiod and thermal variations. The conventional rainy season crop is affected due to aberrant weather conditions and its greater vulnerability to weeds (Mitra and Bhattacharya, 2005) and other insect-pests and diseases. Growth behaviour of this crop differs in different seasons due to variation in temperature, photoperiod, humidity etc. (Dodwadiya and Sharma, 2012). Its initial growth rate is relatively slow and consequently weeds have a smothering effect on crop plants and compete for growth resources (Verma et al., 2008). Mulching reduce evaporation, soil erosion, increasing infiltration and population of micro-organisms, improve soil moisture status, nutrient utilization, soil temperature regulation and can suppress weeds, due to delayed emergence and smothering effect on weeds (Sharma and Singh, 2010; Manhas et al., 2011). Applications of 10 tons of rice or wheat straw as mulch in greengram reduce emergence and growth of weeds and have a favourable effect on yield (Verma et al., 2008). Moreover, straw mulch can add a fair amount of nutrients and improve the physicochemical properties of the soil. By virtue of being a restorer of soil fertility, pulses have a unique position in the cropping system, particularly in dry land or rainfed agriculture (Khanda et al., 2005). Agri-horti system markedly increases the returns per unit of land mainly during early stage of horticultural fruit trees. The relatively short juvenile (pre-production) phase of fruit trees, high market value of products and the contribution of fruits to household dietary needs, fruit-tree-based agro forestry enjoy high popularity among producers worldwide. In *Vindhyan* region of Uttar Pradesh growing of pulses, intercropped with custard apple, guava, bael, *subabool*, and *Kronda* etc., are more suitable under the agri-hortil system.

Greengram is a viable option as an intercrop in the alleys of agri-horticultural plantation which provides extra income and also improves the soil fertility (Muthiah, 2004).

It is a short duration crop needs more attention on weed control. Weeds grow more vigorously and pose as serious threat to its cultivation. Being a rainy season crop, it is heavily infested by a large number of fast growing weeds, especially during the critical period of crop-weed competition. Thus, reduces the yield of greengram by 42–64%. Often 2–3 hand weeding is required to keep the greengram weed free but manual weeding is costly, time consuming and labour intensive also (Singh et al., 2014). However, its additional advantage of providing greater aeration and soil moisture conservation cannot be ignored. But, with the increasing crisis of labour, exploring the possibility of herbicidal weed control in greengram deserves attention. Now a day's herbicide is an integral part of intensive agriculture throughout the world. Herbicide not only save valuable time and money but also allow large coverage in short period of time. Greater knowledge of compatible agro-forestry species greatly facilitates formulation of agroforestry systems with higher yields. Simultaneously, influence of weed management practices on weeds and crops would generate a better understanding to improve crop-weed competition. However, the information on comparative performance of mulching and weed management practices on weeds and nutrients uptake by greengram under agri-horti system is lacking. Keeping above facts in mind the present investigation was carried out to study the effect of mulching and weed management practices on weed and nutrients uptake by greengram under agri-horti system.

2. Materials and Methods

A field study was conducted during the *kharif* seasons of 2013–14 at south campus, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh. The experimental site is located at 85° E longitude and 25° N latitude and at an altitude of 365 m MSL. The experimental soil was sandy clay loam with pH 6.2. The soil was low in available N 176.2 kg ha^{-1}, medium in available P (11.2 kg ha^{-1}) and available K (184.5 kg ha^{-1}). Field capacity (7.9%), permanent wilting point (1.8%) and bulk density (1.53 Mg m^{-3}) were recorded in 0–30 cm soil depth. The experiment was laid out in a split plot design using three mulch treatments viz., M_1-no mulch, M_2-dust mulch (manipulation of soil with *Khurpi* (Spud) after the occurrence of rainfall when soil condition is appropriate) and M_3- paddy straw mulch (6th a^{-1} after the emergence of crop plant at 7th day) were assigned as main-plots, whereas five weed control treatments viz., W_1-weedy check, W_2-weed free (HW at 20 and 40 DAS), W_3- pendimethalin pre-emergence (PE) 1000 g ha^{-1}, W_4-imazethapyr post-emergence (PoE) 100 g ha^{-1} and W_5-pendimethalin (PE) 1000 g ha^{-1} followed by (*fb*) imazethapyr (PoE) 100 g ha^{-1} was randomly allocated to subplots and replicated thrice. The greengram 'HUM- 16' was sown on 19th July 2013 with the help of manual single row drill at 30.0 cm row spacing using 20 kg seed ha^{-1} in 4.0×4.5 m^2 gross plot size under the eight year old custard apple (*Annona squamosa* L.) plantation. Custard apple is one of the delicious and nutritious fruits can be grown in areas with rainfall as low as 400 mm. It was probably introduced into Australia from British Guiana. It is erect, with a rounded or spreading crown and trunk 10 to 14 inches (25–35 cm) thick. Height of the tree ranges from 15 to 35 feet (4.5–10 m) which is at a spacing of 5×5 m^2. Fertilizer was applied 20–60–40 NPK kg ha^{-1} in the form of urea, single super phosphate and murate of potash, respectively. All the nitrogen, phosphorous and potash were applied at the time of sowing. Herbicides was applied in respective treatment combinations with the help of flat fan nozzle attached to the foot sprayer using volume of spray 500 l ha^{-1}. All agronomic and cultural operations were followed for the success the crop. Data on density and dry weight of weed was recorded at 90 DAS from an area enclosed in the quadrate of 0.25 m^{-2} randomly selected at three places in each plot. Oven dry weight of weeds was recorded at 70 °C for 48 hr. and expressed as dry matter g m^{-2}. The crop plants from each net plot were harvested on 18th September 2013 separately and stacked plot wise for sun drying and subsequent threshing. Weed and crop samples were analyzed for nutrient concentration as per the standard procedure. N, P and K uptake (kg ha^{-1}) were calculated by multiplying their nutrient (NPK) concentration with weed biomass and crop yield. Data recorded on various observations analyzed statistically as per the standard analysis of variance to draw valid conclusions.

3. Results and Discussion

3.1. Density and dry weight of weed

All the mulching and weed management treatments significantly reduced the density and dry weight of weeds as compared to no-mulching and weedy check (Table 1). Dust mulching recorded significantly the lowest density and dry weight of weeds over paddy straw mulching. Similar results are also reported by Verma et al. (2016). Sometimes some weeds emerged even after the application of herbicides also, but due to the breaking of soil surface (Dust mulching) after each irrigation or rainfall events weed seedling gets uprooted and die-off and straw mulching also successfully restricts weed emergence (Verma et al., 2016). Density and dry weight reflected the growth potential of the weed and its competitive ability with crop plants. Weedy check recorded the highest density and dry weight of weeds while it was lowest under weed free (HW at 20 and 40 DAS). Among the herbicidal treatments, sequential application of pendimethalin (1000 g ha^{-1}, pre-em) *fb* imazethapyr (100 g ha^{-1}, post-em) recorded lowest density and dry weight of weeds followed by the alone application of pendimethalin (1000 g ha^{-1}, pre-em) and imazethapyr (100 g ha^{-1} post-em), respectively. Lower weed density and dry matter accumulation of weeds under pendimethalin followed by imazethapyr was due to fact that pendimethalin controlled the germination of initial flushes of weeds and imazethapyr controlled weeds emerged at later stages of crop growth. Higher weed control and long lasting effects of pendimethalin and imazethapyr in reducing density and weed dry matter might be primarily due to broad-

Table 1: Effect of mulching and weed management on weeds and crop growth under Custard apple plantation at harvest

Treatment	Weed density (m^{-2})	Weed dry weight (g m^{-2})	Plant height (cm)	Crop dry weight (g $plant^{-1}$)	Branch-es $plant^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Mulching							
No mulching	101.60	9.90	35.47	7.40	3.98	597.33	15.97.33
Dust mulching	26.67	2.81	39.56	11.62	5.38	746.67	1796.67
Paddy straw mulching	67.47	6.61	37.30	9.46	4.52	711.87	1661.87
SEm±	3.99	0.69	0.17	0.05	0.35	4.30	4.32
CD (*p*=0.05)	11.9	2.10	0.55	0.15	1.02	12.92	12.92
Weed management practices							
Weedy check	140.44	13.21	34.01	9.33	3.60	602.78	1602.78
Weed free (HW at 20 and 40 DAS)	0.00	0.00	41.87	11.06	5.71	757.56	1757.56
Pendimethalin 1000 g ha^{-1}	62.67	6.59	36.69	10.17	4.52	689.44	1689.44
Imazethapyr 100 g ha^{-1}	79.56	7.86	35.37	9.68	4.11	650.56	1650.56
Pendimethalin 1000 g+imazethapyr 100 g ha^{-1}	43.56	4.52	39.28	10.55	5.18	726.11	1726.11
SEm±	3.16	0.52	0.22	0.04	0.17	2.79	2.76
CD (*p*=0.05)	9.50	1.53	0.66	0.13	0.54	8.34	8.34

spectrum activity of these herbicides (Verma et al., 2016). Likewise, Gupta et al. (2012) and Singh et al. (2014) also recommended use of imazethapyr in legumes which inhibit acetohydroxy acid synthase and the synthesis of branched chain amino acid in weeds.

3.2. Nutrients contents in weeds

The highest nutrients (NPK) content in weeds were recorded under dust mulching as compared to rice straw mulching (Table 2). The lowest weed dry matter accumulation and the maximum moisture availability under dust mulching mainly leads to highest nutrient accumulation in weeds. The nutrients content in weeds increased with the application of herbicides as compared to weedy check. Lowest nutrients content in weeds under no-mulching was due to the highest partitioning of nutrients. The highest nutrient content in weeds was observed under pendimethalin fb imazethapyr treated plot followed by the alone application of pendimethalin and imazethapyr, respectively. This may be due to lowest density and dry weight of weed, which reduces the partitioning of nutrients. Results are corroborated with the results of Verma et al. (2016)

3*.3. Nutrients depletion by weeds*

The nutrients depletion by weeds increased with increasing the dry matter accumulation by weeds and significantly the highest depletion of nutrients by weeds was recorded under rice straw mulching as compared to dust mulching (Table 3). It could be attributed to the maximum dry weight of weeds under rice straw mulching, which helped in maximum accumulation of nutrients by weeds (Verma et al., 2008 and Verma et al., 2016). Herbicidal treatments significantly influenced on the nutrients depletion by weeds. It was significantly the highest under alone application of imazethapyr followed by pendimethalin. The increase in the depletion of nutrients by weeds under this treatment was due to poor control of weeds resulted highest dry weight of weed, which corroborated with the findings of Singh et al. (2014).

3.4. Crop growth

Dust mulching recorded significantly tallest plant, highest dry matter accumulation and maximum branches $plant^{-1}$ as compared rice straw mulching and no-mulching, respectively (Table 1). This might be due to fact that the repeated interculture operation for dust mulching obtain weed free situation which provides adequate moisture availability and facilitated nutrient uptake by crop resulted better growth and development as compared to other treatments. Similar results also reported by Verma et al. (2016). Among the herbicidal treatments, sequential application of pendimethalin followed by imazethapyr recorded significantly the tallest plant, highest dry matter accumulation and branches $plant^{-1}$ as compared to the alone application of pendimethalin and imazethapyr, respectively. Results are in close conformity with the findings of Singh et al. (2014).

3.5. Nutrients content in grain and straw

The highest nutrients content in grains and straw were recorded under dust mulching as compared to rice straw mulching (Table 2). The lowest weed dry matter accumulation and the maximum moisture availability under dust mulching mainly leads to highest nutrient accumulation in grains and straw. Among herbicidal treatments, highest nutrient content in grain and straw was observed under sequential application of pendimethalin *fb* imazethapyr treated plot as compared to the alone application of pendimethalin and imazethapyr,

Table 2: Effect of mulching and weed management on nutrient content in weeds and greengram

Treatment	Nutrient content in weeds (%)			Nutrient content in grain (%)			Nutrient content in straw (%)		
	N	P	K	N	P	K	N	P	K
Mulching									
No mulching	1.48	0.19	2.03	3.15	0.32	1.02	1.03	0.18	2.16
Dust mulching	1.58	0.22	2.22	3.30	0.35	1.06	1.11	0.21	2.22
Paddy straw mulching	1.54	0.21	2.19	3.23	0.33	1.03	1.06	0.20	2.17
SEm±	0.07	0.02	0.08	0.05	0.01	0.02	0.02	0.01	0.03
CD (*p*=0.05)	0.20	0.05	0.24	0.14	0.03	0.05	0.06	0.04	0.09
Weed management practices									
Weedy check	1.42	0.19	2.10	3.19	0.32	1.01	1.05	0.17	2.09
Weed free (HW at 20 and 40 DAS)	1.66	0.23	2.19	3.31	0.35	1.06	1.09	0.23	2.27
Pendimethalin 1000 g ha^{-1}	1.51	0.20	2.14	3.21	0.34	1.03	1.07	0.19	2.19
Imazethapyr 100 g ha^{-1}	1.45	0.19	2.13	3.20	0.33	1.02	1.05	0.19	2.17
Pendimethalin 1000 g+imazethapyr 100 g ha^{-1}	1.61	0.22	2.16	3.22	0.34	1.05	1.08	0.21	2.21
SEm±	0.04	0.01	0.04	0.04	0.01	0.01	0.02	0.01	0.03
CD (*p*=0.05)	0.13	0.04	0.13	NS	NS	NS	NS	NS	NS

Table 3: Effect of mulching and weed management practices on grain straw and biological yield of greengram

Treatment	Nutrient depletion by weeds (kg ha^{-1})			Nutrient uptake by grain (kg ha^{-1})			Nutrient uptake by straw kg ha^{-1})			Total nutrient uptake by crop (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K	N	P	K
Mulching												
No mulching	1.37	0.17	1.98	18.81	1.94	6.09	16.49	2.94	34.6	35.3	4.89	40.7
Dust mulching	0.43	0.05	0.61	26.38	2.77	8.43	19.93	3.83	40.0	46.3	6.61	48.5
Paddy straw mulching	1.00	0.14	1.44	21.36	2.20	6.81	17.68	3.36	36.1	39.0	5.57	42.9
SEm±	0.08	0.01	0.08	0.44	0.06	0.12	0.38	0.23	0.78	0.72	0.24	0.82
CD (*p*=0.05)	0.25	0.03	0.28	1.36	0.19	0.35	1.17	0.69	2.32	2.18	0.75	2.50
Weed management practices												
Weedy check	1.75	0.24	2.75	19.22	1.94	6.13	16.76	2.77	33.5	35.9	4.71	39.6
Weed free (HW at 20 and 40 DAS)	0.00	0.00	0.00	25.21	2.65	8.06	19.27	4.00	40.0	44.5	6.64	48.1
Pendimethalin 1000 g ha^{-1}	1.01	0.13	1.38	22.15	2.32	7.08	18.01	3.30	36.9	40.2	5.62	44.1
Imazethapyr 100 g ha^{-1}	1.16	0.14	1.63	20.87	2.17	6.65	17.35	3.21	35.8	38.2	5.37	42.4
Pendimethalin 1000 g+imazethapyr 100 g ha^{-1}	1.16	0.10	0.97	23.46	2.46	7.63	18.78	3.63	38.1	42.2	6.09	45.8
SEm±	0.06	0.01	0.08	0.37	0.04	0.08	0.34	0.20	0.54	0.72	0.25	0.60
CD (*p*=0.05)	0.17	0.03	0.24	1.15	0.15	0.26	1.04	0.62	1.66	2.18	0.74	1.84

respectively. Results are close conformity with the research findings of Verma et al. (2016).

3.6. Yield and nutrient uptake

Among mulching, dust mulching recorded significantly highest grain and straw yield and nutrients uptake as compared to rice straw mulching. Higher yield and nutrient uptake under dust mulching was due to lowest dry weight of weeds and the better growth and development of crop. Among the weed control treatments, significantly highest yield and nutrients

uptake was found under weed free treatment and lowest in control plot. A sequential application of pendimethalin followed by (*fb*) imazethapyr recorded significantly the highest yield and nutrients uptake over alone application of pendimethalin and imazethapyr. This was due to effective control of weeds resulting into better crop growth, yield and nutrients uptake. Results are corroborated with the results of Singh et al. (2014) and Verma et al. (2016).

3.7. Economics

Dust mulching gave highest gross and net returns followed by paddy straw mulching and no mulching, respectively (Table 4). Among herbicidal treatments, sequential application of pendimethalin followed by (*fb*) imazethapyr recorded highest gross and net returns as compared to pendimethalin and imazethapyr, respectively. None of the herbicidal treatments reach to the level of weed free situation with respect to gross and net returns. Maximum gross and net returns were under weed free condition is the result of highest grain and straw yield of greengram. However, no mulching recorded maximum B: C ratio in among the mulches and alone application of pendimethalin recorded maximum B:C ratio as compared to other weed management treatments. Similar result were also reported by Verma et al. (2008); Idnani and Gautam (2008).

Table 4: Effect of mulching and weed management practices on economics of greengram

Treatment	Total cost (g ha^{-1})	Gross return (g ha^{-1})	Net return (g ha^{-1})	B:C ratio
Mulches				
No mulching	20186	91662	71477	3.55
Dust mulching	24058	104887	80830	3.36
Paddy straw mulching	27126	101635	74509	2.75
Weed management practices				
Weedy check	22344	94071	71727	3.26
Weed free (HW at 20 and 40 DAS)	26224	105236	79012	3.04
Pendimethalin (PE) 1000 g ha^{-1}	23242	99012	75769	3.30
Imazethapyr (PoE) 100 g ha^{-1}	23114	97102	73989	3.24
Pendimethalin (PE) 1000 g ha^{-1}+Imazethapyr (PoE) 100 g ha^{-1}	24026	101555	77529	3.26

4. Conclusion

Dust mulching and sequential application of pendimethalin followed by (*fb*) imazethapyr recorded significantly the lowest density and dry weight of weeds and the highest grain and straw yield, nutrients uptake and net returns over alone application of pendimethalin and imazethapyr.

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