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Effect of mulching and herbicides on weeds, yield and economics of greengram (*Vigna radiata* L.) grown under eight-year old agri-horti system

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ABSTRACT

A field experiment with the objectives to understand the effect of mulching and herbicides on weed infestation and greengram yield involving two factors viz., mulching (no mulching, dust mulching and paddy straw mulching) and herbicidal treatments (weedy check, hand weeding at 20 and 40 days after sowing, pendimethalin pre-emergence @1000 g/ha, imazethapyr post-emergence @ 100 g/ha, and pendimethalin pre-emergence @ 1000 g/ha followed by imazethapyr post-emergence @ 100 g/ha) was undertaken in split-plot design with three replications at South Campus, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India. Results revealed that dust mulching and sequential application of pendimethalin followed by imazethapyr recorded lower weed density, weed dry weight, nutrients depletion by weed and maximum crop yield as well as net returns over rest of the mulching and herbicidal treatments. Therefore, it is suggested that the combination of mulching and herbicides may be used for effective weed management and optimal yield of greengram under agri-horti system.

Key words : Agri-horti system, greengram, herbicides, mulching, nutrient content & uptake, weed management

INTRODUCTION

The pulses constitute an important group of crops and have been the main stay in Indian agriculture, as they improve physical condition of soil and also provide nutritious food and fodder to human and livestock, respectively. India has a distinction of being world's largest producer of pulses. However, India needs to make immediate strides in pulse production programme taking into account the extreme relevance of pulses in our diet. Among the grain legumes, greengram ranks third after chickpea and pigeonpea in respect of production, and it may also be grown throughout the year (Tamang *et al.,* 2015). Greengram is one of the major pulse crops of India, cultivated in arid and semi-arid regions in nearly 3.35 M ha area with 1.82 MT production and 512 kg/ha average productivity (Komal *et al.,* 2015). The yield of greengram is very low in developing countries like India as compared to developed countries. The lower productivity of greengram is mainly due to lack of improved cultural practices.

Weeding and hoeing are common cultural and manual weed management methods for greengram. Manual weeding at right stage is difficult, time consuming and expensive due to intermittent rainfall during rainy season and scanty labour, therefore, farmers rarely adopt manual weeding for weed

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control. Under such situation, herbicides use with suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable to compete weed control because of their selective kill. Their use can be made more effective, if supplemented with hand weeding or hoeing, etc. Integrated weed management involving use of suitable herbicides together with hand weeding, mulching provides more efficient and cost-effective control of weeds (Singh, 2009; Kalhapure and Shete, 2013). Agri-horti-system markedly increases the returns per unit of land mainly during early stage of horticultural fruit trees. Greater knowledge of compatible agro-forestry species greatly facilitates formulation of agroforestry systems with higher yield (Koodi, 2010). Greengram is considered a viable option as an intercrop in the alleys of agri-horti-system and provides extra income, improves the fertility of the soil (Kushwaha, 2010). However, meagre information is available on the effect of weed management practice and mulching on weeds, yield and economics of rainfed greengram particularly in Vindhyan region of Uttar Pradesh. Keeping the above points and the known possible reasons in mind, the present study was undertaken to evaluate the effect of mulching and herbicides on weeds, yield and economics of greengram in agri-horti system.

MATERIALS AND METHODS

A field experiment was carried out at South Campus, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India (Latitude : 25°10′, Longitude : 82°37′ and Altitude : 168 m) during the **kharif** season of 2013-14. The experimental soil was sandy clay loam in texture with pH 6.2. The soil was low in available N (176.2 kg/ha), medium in available P (11.2 kg/ha) and available K (184.5 kg/ha). The field capacity (7.9%), permanent wilting point (1.8 %) and bulk density (1.53 Mg/ m^3) was recorded from 0-30 cm soil depth. The soil was prepared according to the local practices for greengram production. The greengram variety 'HUM- 16' was sown on 19 July 2013 with the help of manual single row drill at a depth of 4 cm and in 30 cm inter row spacing using 20 kg seed/ha in 4.0 x 4.5 m^2 gross plot size under the eight-year old custard apple (*Annona squamosa* L.) plantation. The height of the trees during the experiment ranged from 15 to 35 feet (4.5-10 m). The NPK fertilizer (20-60-40 kg/ha) was applied in the form of urea, single super phosphate and murate of potash, respectively. All the fertilizers were applied at the time of sowing. All need-based agronomic and cultural operations were followed for growing of experimental crop.

The experiment was laid out in 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 was appropriate) and M_3–Paddy straw mulch (6 t/ha after the emergence of crop) as main-plot treatment and five weed control treatments viz., W_1–Weedy check, W_2–Two hand weedings at 20 and 40 days after sowing (DAS), W_3–Pendimethalin pre-emergence (PE) 1000 g/ha, W_4–Imazethapyr post-emergence (PoE) 100 g/ha and W_5–Pendimethalin (PE) 1000 g/ha followed by (*fb*) imazethapyr (PoE) 100 g/ha as sub-plot treatments. The herbicides spray as per treatment combinations was undertaken with the help of flat fan nozzle attached to the foot sprayer using spray volume of 500 l/ha. The density and dry weight of weeds were assessed at 60 DAS with the help of wooden square quadrate (1 × 1 m) by placing quadrate randomly three times in each plot. The weeds existing in the 1 × 1 m areas were counted and categorized as grassy, broad-leaved weeds and sedges, and were also uprooted for dry matter determination. The net plot area after isolating border plants was marked and harvested on 18 September 2013 and subsequently used for recording grain and straw yield.

Nutrient uptake was calculated by using following equation :

Nutrient uptake (kg/ha)=Nutrient content (%) x Dry matter of weeds or crop (kg/ha) x 100

The data recorded under study were analyzed as per procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Weed Studies

Weed flora of experimental field consisted of grassy, broad-leaved weeds (BLW) and sedges in order of dominance. The major weed flora recorded in weedy check plots were

Cyperus rotundus L. (26.4%), *Echinochloa colona* L. (25.8%), *Cynodon dactylon* Pers. (24.7%) and *Erogrostis pilosa* L. (23.1%). Both the mulching treatments proved superior to no-mulching in reducing weed density and dry weight of grassy, BLW and sedges. The lower density and dry weight of grassy, BLW and sedges were recorded under dust mulching (Table 1). The decrease in weed density and dry weight under dust mulching might be due to repeated soil manipulation that creates unfavourable environment for weed seedlings (Verma *et al.,* 2016). Sequential application of pendimethalin (PE) *fb* imazethapyr (PoE) recorded the lowest weed density and dry weight of grassy, BLW and sedges as compared to sole application of pendimethalin (PE) and imazethapyr (PoE), respectively.This might be due to control of weeds during early growth stage by PE application of pendimethalin and PoE application of imazethapyr at 20 DAS. The combination of PE and PoE herbicides was also able to control broad spectrum of weeds in the crop. Further, the crop covered the soil surface and smothered the growth of weeds resulting in least number of weeds at later stage of crop growth (Komal *et al.,* 2015; Verma *et al.,* 2016). Two hand weedings at 20 and 40 DAS were found more effective than the herbicides. It may due to slow pace of growth of first flush of weeds, 20 DAS thereafter the emergence of new flushes of weeds could not attain full growth under the shade of crop plants. These results are in conformity with the findings of Koodi (2010) and Kushwaha (2010). They also reported the superiority of hand weeding over herbicidal treatments.

Crop Studies

The results showed remarkable variation in growth and yield attributes of greengram due to mulching and herbicides application (Table 2). Among the mulching treatments, dust mulching recorded significantly higher plant height, maximum functional root nodules, pod length, grains/pod and 1000-grain weight. This increase was observed to the tune of 8.60, 21.5, 15.9, 10.7 and 4.23%, respectively, over paddy straw mulching. Less competition among the plants for resources like moisture and nutrients was due to less density and dry weight of weeds which might have led to an increased availability of resources, resulting in highest growth and yield attributes of greengram under dust mulching (Verma *et al.,* 2008; Mirjha *et al.,* 2013). It was also seen that two hand weedings and herbicides application significantly enhanced growth and yield characteristics compared to weedy check. Two hand weedings at 20 and 40 DAS recorded significantly the maximum plant height, functional root nodules, pod length, grains/pod and 1000-grain weight than the herbicidal treatments. Sequential application of pendimethalin (PE) *fb* imazethapyr (PoE) recorded significantly higher plant hieght, maximum functional root nodules, pod length, grains/pod and 1000-grain weight over sole application of either pendimethalin (PE) or imazethapyr (PoE), respectively. This increase was to the tune of 13.3, 10.9, 8.53, 7.16 and 6.72%, respectively, over weedy check. These results are in agreement with the findings of Singh *et al.* (2014) and Khairnar *et al.* (2014). It was observed that the nodule number/plant reduced with increase in weed density and dry biomass (Table 1).

Verma *et al.* (2008) and Singh *et al.* (2014) also reported higher nodulation under effective weed management practices in greengram and chickpea, respectively. Weeding facilitates plants to have more resources for growth and development. This may be attributed to less competition for crop to light, nutrients, and free space in weed free environment (Komal *et al.,* 2015). There was significant variation in crop characteristics among the treatment combinations. Interaction between the mulching and herbicides was statistically significant (P=0.05) with respect to crop yield (Table 2). The highest grain, straw and biological yield was recorded under dust mulching along with two hand weedings at 20 and 40 DAS followed by dust mulching with the sequential application of pendimethalin (PE) *fb* imazethapyr (PoE). However, no mulching with weedy check was adjudged the lowest performer. The tremendous weed infestation in no mulching and weedy check treatment drastically reduced the yield of the crop. Similar findings were also reported by Verma *et al.* (2008), Sharma *et al.* (2011) and Khairnar *et al.* (2014).

Economic Studies

The economic calculations worked out are presented in Table 1. The variations

Table 1. Weed density and dry weight, root nodules, yield attributes and economics of greengram as influenced by mulching and herbicides

Treatment	Weed density (m^2)			Weed dry weight (g/m^2)			Plant height (cm)	Root nodules/ plant	Pod length (cm)	Grains/ pod	1000-grain weight (g)	Total cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B : C ratio
	Grasses	BLW	Sedges	Grasses	BLW	Sedges									
Mulching															
No mulching	61.9	32.8	35.2	5.98	2.97	4.12	33.1	10.5	6.62	10.05	29.65	20186	91662	71477	3.55
Dust mulching	18.9	10.4	8.0	1.60	0.80	0.66	37.3	16.3	8.43	11.80	32.34	24058	104887	80830	3.36
Paddy straw mulching	44.3	21.3	24.3	4.11	1.48	3.14	34.9	12.8	7.09	10.54	30.97	27126	101635	74509	2.75
C. D. (P=0.05)	5.1	2.42	2.53	0.77	0.46	0.75	0.82	1.22	0.09	0.03	0.20	-	-	-	-
Herbicides											3.26				
Weedy check	92.0	42.2	47.6	8.60	3.64	5.12	31.9	12.2	6.97	10.25	29.54	22344	94071	71727	3.04
Hand weeding (at 20 and 40 DAS)	0.00	0.00	0.00	0.00	0.00	0.00	39.1	14.4	7.77	11.29	32.19	26224	105236	79012	3.30
Pendimethalin 1000 g/ha	40.9	21.3	21.3	3.87	1.68	2.67	34.5	13.1	7.38	10.82	31.05	23242	99012	75769	3.24
Imazethapyr 100 g/ha	52.0	26.2	28.0	4.62	1.78	3.38	33.2	12.7	7.16	10.59	30.48	23114	97102	73989	3.26
Pendimethalin 1000 g *fb* imazethapyr 100 g/ha	23.6	17.8	15.6	2.42	1.36	2.04	36.8	13.7	7.62	11.04	31.67	24026	101555	77529	
C. D. (P=0.05)	0.72	1.26	0.34	0.17	0.08	0.12	0.74	0.28	0.15	0.06	0.17	-	-	-	-

Table 2. Interaction effect of mulching and weed management practices on grain yield, straw yield and biological yield of greengram

Treatment/ Weed management practices	Mulching			
	No mulching	Dust mulching	Paddy straw mulching	Mean
		Grain yield (kg/ha)		
Weedy check	522	714	573	603
Hand weeding (at 20 and 40 DAS)	664	870	739	757
Pendimethalin (PE) 1000 g/ha	600	800	666	689
Imazethapyr (PoE) 100 g/ha	568	758	626	651
Pendimethalin (PE) 1000 g/ha *fb* imazethapyr (PoE) 100 g/ha	634	840	705	726
Mean	597	796	761	
C. D. (P=0.05)		176		
		Straw yield (kg/ha)		
Weedy check	1522	1714	1573	1603
Hand weeding (at 20 and 40 DAS)	1664	1870	1749	1761
Pendimethalin (PE) 1000 g/ha	1600	1800	1666	1689
Imazethapyr (PoE) 100 g/ha	1568	1758	1626	1651
Pendimethalin (PE) 1000 g/ha *fb* imazethapyr (PoE) 100 g/ha	1634	1840	1705	1726
Mean	1597	1796	1664	
C. D. (P=0.05)		78.0		
		Biological yield (kg/ha)		
Weedy check	2044	2427	2146	2205
Hand weeding (at 20 and 40 DAS)	2327	2740	2488	2518
Pendimethalin (PE) 1000 g/ha	2200	2600	2332	2377
Imazethapyr (PoE) 100 g/ha	2137	2517	2251	2302
Pendimethalin (PE) 1000 g/ha *fb* imazethapyr (PoE) 100 g/ha	2267	2680	2410	2452
Mean	2195	2593	2325	
C. D. (P=0.05)		84.3		

observed in gross returns under different mulching and weed management treatments were due to differences in cost of cultivation and yield of greengram as well as custard apple attained in different treatments along with their respective sale rates. Among the mulching treatments, the highest cost of cultivation was recorded in paddy straw mulching due to higher price of straw and engagement of extra labour for spreading of straw in between the crop rows. However, among the weed management treatments, two hand weedings were proved costly and recorded highest cost of cultivation due to higher labour cost. No-mulching performed fairly better with respect to B : C ratio over dust mulching and paddy straw mulching due to lower cost of cultivation. Two hand weedings undertaken at 20 and 40 DAS yielded highest gross as well net returns over the remaining weed management treatments but failed in B : C ratio and recorded lowest B : C ratio (3.04) in comparison to rest of the tested treatments. The higher B : C ratio was recorded in sole application of pendimethalin (PE) (3.30) followed by sequential application of pendimethalin (PE) *fb* imazethapyr (PoE). These results corroborate with the findings of Koodi (2010); Kushwaha (2010) and Khan *et al.* (2011).

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