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RESEARCH ARTICLE :

Study of manual efficiency V/S mechanical efficiency in harvesting of paraquat applied greengram genotypes

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SUMMARY : The field experiment were carried out to study the "Effect of paraquat on efficiency of mechanical and manual harvesting of greengram [*Vigna radiata* (L.) Wilczek] genotypes" at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The field experiment was laid out in split- split plot design with two main plots (methods of harvesting), three sub plots (genotypes) and two sub sub plots (paraquat spray and control). The methods of harvesting and genotypes did not record significant difference with respect to yield butspraying of paraquat recorded significantly higher seed yield (1,269 kg ha^{-1}) compared to control. Among the interactions, mechanical harvesting of all the three genotypes with paraquat recorded significantly higher seed yield (1,304 – 1,245 kg ha^{-1}), field efficiency (91.79 - 90.45 %), harvest efficiency (521 - 498 kg ha^{-1}). Whereas mechanical harvesting of genotypes without paraquat spray recorded significantly higher threshing loss (5.90 - 5.19 %). Mechanical harvesting of greengram aim is to getting the benefit was not from higher greengram yields but from the lower cost of labour required for harvesting, timely harvesting of greengram.

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BACKGROUND AND OBJECTIVES

There is less scope for production of greengram because of many production constraints like non availability of quality seeds of improved, long stature, short duration varieties. Delay in harvesting which cause shattering of pod, rains during later stage deteriorate quality and create problem in harvesting of crop. Apart from million tonnes these in recent years, large number of labours migrated from rural to city due to rapid industrialization and urbanization which created a problem of scarcity of labour during harvesting. To overcome these problems we need to go for mechanical harvesting.

The mechanical harvesting is done by combiner harvester, which was introduced in the early 1990s. The combiner could harvest 2.4 to 3.0 acres in one hour. Cutting height during combiner harvesting is often higher than with other harvesting methods. The time interval for harvest by combiner harvester is

often narrow, too early harvesting will result in a high percentage of chaffy kernels, and too late harvesting will result in high shattering losses. The optimum threshing drum speed depends on grain moisture content, volume of material entering the combiner, weeds etc. Fine tuning forward speed and header height is especially important to minimize field loss (Anonymous, 2013). Combiner is an efficient, economical and less labour and time consuming machine, in addition 2 to 3 weeks of saving in harvesting time (Upasana, 2015).

Further, suitability of variety for mechanical harvesting, greenish nature of leaves even after maturation of pod, the indeterminate flowering habit of greengram and high moisture of stalk could affect working efficiency of machine, which led to increased harvesting loss and storage difficulty (Abdul *et al.*, 2003). Paraquat application result into complete defoliation takes place, with in 3-4 days.Main objective of defoliation is to promote crop earliness, facilitate shedding of leaves before harvesting at an appropriate time and to ensure clean and fast picking of pods and reduce losses.

RESOURCES AND METHODS

The field experiment was conducted at Main Agricultural Research Station, Dharwad, *Kharif* -2015.

The field experiment was laid out in split- split plot design with two main plots (methods of harvesting), three sub plots (genotypes) and two sub sub plots (paraquat spray and control). The soil was medium deep black soil with pH 7.10. The available N, P_2O_5 and K_2O contents were 240.5, 23.5 and 354.6 kg ha^{-1}, respectively. FYM (5 t ha^{-1}) was applied 15 days before sowing of the crop.

For sowing, two seeds per hill were dibbled 5 cm deep in furrows at a spacing of 30 cm x 10 cm. Recommended dose of N and P_2O_5 were applied as basal at the time of sowing. The crops were harvested at their

Table 1: Seed yield (kg ha^{-1}) and threshing loss (%) of greengram as influenced by method of harvesting, paraquat spray and genotype

Treatments		Seed yield (kg ha^{-1})			Threshing loss (%)		
		Spray					
Harvesting	Genotypes	D_1	D_2	Mean	D_1	D_2	Mean
H_1	G_1	1245	990	1117	2.83	5.19	4.01
	G_2	1304	920	1112	2.89	5.90	4.39
	G_3	1290	911	1101	2.87	5.59	4.23
	Mean	1280	940	1110	2.87	5.56	4.21
H_2	G_1	1224	1165	1195	2.52	2.94	2.73
	G_2	1294	1208	1251	2.61	2.83	2.72
	G_3	1256	1169	1213	2.51	2.98	2.75
Mean of H	Mean	1258	1181	1219	2.55	2.92	2.73
	G_1	1234	1078	1156	2.68	4.07	3.37
	G_2	1299	1064	1181	2.75	4.36	3.56
	G_3	1273	1040	1157	2.69	4.28	3.49
Mean		1269	1061		2.71	4.24	
For comparison of means			S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	
H			21	NS	0.08	0.51	
G			18	NS	0.10	NS	
D			23	72	0.09	0.29	
H x G			25	81	0.14	0.47	
H x D			33	101	0.13	0.41	
G x D			40	124	0.16	0.50	
H x G x D			57	176	0.23	0.71	

Main plot- Methods of harvesting (H)
H_1: Mechanical harvesting
H_2: Manual harvesting

Sub plot - Genotype (G)
G_1: DGGV-2
G_2: DGG-1
G_3: Nirmal (popular local variety)

Sub sub plot- Defoliator chemical (D)
D_1: Paraquat @ 4ml l^{-1}
D_2: Control
NS= Non-significant

physiological maturity. The data was analysed statistically based on mean values obtained. The level of significance used in 'F' and 'T' test was P = 0.05 (Gomez and Gomez, 1984).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Seed yield (kg ha^{-1}):

Seed yield of greengram did not differ significantly due to the methods of harvesting. The crop harvested by manual method evidenced higher seed yield (1219 kg ha^{-1}) compared to mechanical method of harvesting (1110 kg ha^{-1}). There was no significant difference in yield of different genotypes. Among Paraquat sprayed treatments significantly higher seed yield (1269 kg ha^{-1}) than control (1061 kg ha^{-1}). Among the interactions of harvesting methods, genotypes and paraquat spray (H×G×D), mechanically harvested genotypes sprayed with paraquat recorded significantly higher yield (1245 - 1304 kg ha^{-1}) over all the genotypes harvested mechanically without spraying of paraquat 911- 990 kg ha^{-1} and interaction of manual harvesting, genotypes, with paraquat spray did not show any significant difference among them (Table 1).

Threshing loss (%), damaged grains(%) and unthreshed pods (%) :

Methods of harvesting had significant difference on threshing loss, damaged grainsand unthreshed pods. Mechanical harvesting showed significantly higher threshing loss (4.21 %), damaged grains (0.65 %) and unthreshed pods (3.37 %) than manual method of harvesting (2.73 %, 0.50 % and 2.16 %, respectively). Paraquat spray recorded significantly lower threshing loss, damaged grains and unthreshed pods (2.71 %, 0.47 %

Table 2: Damaged grains (%) and unthreshed pods (%) of greengram as influenced by method of harvesting, paraquat spray and genotype

Treatments		Damaged grains (%)			Unthreshed pods (%)		
		Spray					
Harvesting	Genotypes	D_1	D_2	Mean	D_1	D_2	Mean
H_1	G_1	0.46	0.79	0.63	2.30	4.14	3.22
	G_2	0.52	0.86	0.69	2.29	4.70	3.50
	G_3	0.48	0.81	0.64	2.32	4.48	3.40
	Mean	0.48	0.82	0.65	2.30	4.44	3.37
H_2	G_1	0.46	0.54	0.50	2.00	2.32	2.16
	G_2	0.44	0.54	0.49	2.10	2.20	2.15
	G_3	0.46	0.54	0.50	2.00	2.36	2.18
Mean of H	Mean	0.45	0.54	0.50	2.03	2.29	2.16
	G_1	0.46	0.67	0.56	2.15	3.23	2.69
	G_2	0.48	0.70	0.59	2.19	3.45	2.82
	G_3	0.47	0.68	0.57	2.16	3.42	2.79
Mean		0.47	0.68		2.17	3.37	
For comparison of means			S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	
H			0.007	0.041	0.07	0.43	
G			0.014	NS	0.08	NS	
D			0.012	0.038	0.07	0.23	
H x G			0.020	0.067	0.11	0.36	
H x D			0.018	0.054	0.10	0.32	
G x D			0.022	0.066	0.13	0.39	
H x G x D			0.030	0.094	0.18	0.55	

Main plot- Methods of harvesting (H)
H_1: Mechanical harvesting
H_2: Manual harvesting

Sub plot - Genotype (G)
G_1: DGGV-2
G_2: DGG-1
G_3: Nirmal (popular local variety)

Sub sub plot- Defoliator chemical (D)
D_1: Paraquat @ 4ml l^{-1}
D_2: Control
NS= Non-significant

and 2.17 %, respectively) compared to non-sprayed treatment (4.24 %, 0.47 % and 3.37 %, respectively). Greengram genotypes did not influence significantly the threshing loss, damaged grains and unthreshed pods. However, the interactions of harvesting, genotypes and paraquat spray H×G×D, mechanically harvested DGG-1 without paraquat recorded significantly higher threshing loss (5.90%), damaged grains (0.86%) and unthreshed pods (4.70%) over all other interactions except mechanically harvested Nirmal without paraquat (5.59%, 0.81% and 4.48%, respectively) and mechanically harvested DGG-1 without paraquat 5.19%, 0.79% and 4.14%, respectively (Table 1 and 2).

Field efficiency (%) and harvest efficiency (kg h^{-1}):

Methods of harvesting had significant difference on field efficiency and harvest efficiency. Mechanical harvesting showed significantly higher field efficiency and harvest efficiency (444 kg h^{-1} and 86.14%) than manual method of harvesting (8 kg h^{-1} and 72.64 %). Paraquat spray recorded significantly recorded significantly higher harvest efficiency and field efficiency (260 kg h^{-1} and 82.43%) compared to non-sprayed treatment (8 kg h^{-1} and 76.35 %). Greengram genotypes did not influence significantly the threshing loss, damaged grains and unthreshed pods.Among the interactions of methods of harvesting, genotypes and paraquat spray (H×G×D), mechanical harvesting of DGG-1 with paraquat spray recorded significantly higher field efficiency and harvest efficiency (91.79 % and 521 kg h^{-1}) than all other interactions except mechanical harvesting of Nirmal with paraquat spray (90.85 % and 516 kg h^{-1}) and mechanical harvesting of DGGV-2 with paraquat spray 90.45 % and 498 kg h^{-1} (Table 3).

Harvest per cent (%) and grain purity (%) :

Methods of harvesting had significant difference on field efficiency and harvest efficiency. Mechanical

Table 3: Field efficiency (%) and harvest efficiency (kg h^{-1}) of greengram as influenced by method of harvesting, paraquat spray and genotype

Treatments		Field efficiency (%)			Harvest efficiency(kg h^{-1})		
		Spray					
Harvesting	Genotypes	D_1	D_2	Mean	D_1	D_2	Mean
H_1	G_1	90.45	80.40	85.43	498	396	447
	G_2	91.79	82.54	87.16	521	368	445
	G_3	90.85	80.80	85.83	516	364	440
	Mean	91.03	81.25	86.14	512	376	444
H_2	G_1	74.25	71.30	72.77	9	8	8
	G_2	73.34	71.30	72.32	9	8	9
	G_3	73.91	71.76	72.83	9	8	8
Mean of H	Mean	73.83	71.45	72.64	9	8	8
	G_1	82.35	75.85	79.10	253	202	227
	G_2	82.56	76.92	79.74	265	188	227
	G_3	82.38	76.28	79.33	262	186	224
Mean		82.43	76.35		260	192	
For comparison of means			S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	
H			1.03	6.26	3	19	
G			0.21	NS	6	NS	
D			0.24	0.75	8	24	
H x G			0.29	0.95	9	30	
H x D			0.34	1.06	11	34	
G x D			0.42	1.29	14	42	
H x G x D			0.59	1.83	19	59	

Main plot- Methods of harvesting (H) Sub plot - Genotype (G) Sub sub plot- Defoliator chemical (D)
H_1: Mechanical harvesting G_1: DGGV-2 D_1: Paraquat @ 4ml l^{-1}
H_2: Manual harvesting G_2: DGG-1 D_2: Contro NS= Non-significant

harvesting showed significantly lesser harvest per cent and grain purity (96.6 % and 96.0 %) than manual harvesting (97.8 % and 97.3 %).There was no significant difference recorded between genotypes with respect to harvest per cent and grain purity. Paraquat spray recorded significantly recorded significantly higher harvest per centand grain purity (97.8 % and 97.4 %) compared to non sprayed treatment (96.6 % and 96.0 %).In interactions of methods of harvesting, genotypes and paraquat spray (H×G×D), mechanical harvesting of mechanically harvested DGG-1 without paraquat recorded significantly lower harvest per cent and grain purity (95.3% and 94.4 %) over all other interactions except mechanically harvested Nirmal without paraquat (95.5and 94.7 %) and mechanically harvested DGGV-2 without paraquat 95.8 and 95.1 % (Table 4).

Among the harvesting methods, mechanical harvesting recorded higher harvest loss which was due to higher damaged grains per cent (0.74 %), unthreshed pods per cent (3.38 %) and threshing loss (4.33 %) compared to manual method of harvesting. In mechanical method of harvesting the harvest loss was mainly. Attributed to feed rate, cylinder speed and screen size. The results are in conformity with the findings of Saxena *et al.* (1987); Lather *et al.* (2000); Turnar (2001); Rahim zadeh *et al.* (2006) and Upasana (2015).

Grain purity of greengram genotypes was higher in manual harvesting (97.3 %) compared to mechanical harvesting (96.0 %). Harvest per cent also higher in manual method of harvesting (97.3 %) than mechanical method of harvesting (96.6 %). This was attributed to higher number of damaged grains (0.65 %) and unthreshed pods (3.37 %) in mechanical harvesting compared to manual harvesting 0.50 % and 2.16 %, respectively. These results are in line with those of Mohammad *et al.* (2013) and Somanagouda (2013).

The harvest efficiency was higher (444 kg h^{-1}) in mechanical method of harvesting compared to manual method of harvesting (8 kg h^{-1}). Similarly field efficiency was significantly higher in mechanical harvesting (86.14 %) than manual harvesting (72.64 %). This is the situation because in mechanical harvesting saving of time (productive time was higher in mechanical harvesting and in short period of time it harvested large area) was

Table 4: Harvest per cent (%)and grain purity (%)of greengram as influenced by method of harvesting, paraquat spray and genotype

Treatments		Harvest per cent (%)			Grain purity (%)		
		Spray					
Harvesting	Genotypes	D_1	D_2	Mean	D_1	D_2	Mean
H_1	G_1	97.7	95.8	96.8	97.2	95.1	96.2
	G_2	97.7	95.3	96.5	97.2	94.4	95.8
	G_3	97.7	95.5	96.6	97.2	94.7	96.0
	Mean	97.7	95.5	96.6	97.2	94.7	96.0
H_2	G_1	98.0	97.7	97.8	97.5	97.1	97.3
	G_2	97.9	97.8	97.8	97.5	97.3	97.4
	G_3	98.0	97.6	97.8	97.5	97.1	97.3
Mean of H	Mean	98.0	97.7	97.8	97.5	97.2	97.3
	G_1	97.8	96.8	97.3	97.4	96.1	96.7
	G_2	97.8	96.5	97.2	97.3	95.8	96.6
	G_3	97.8	96.6	97.2	97.4	95.9	96.6
Mean		97.8	96.6		97.4	96.0	
For comparison of means			S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	
H			0.07	0.44	0.08	0.47	
G			0.08	NS	0.09	NS	
D			0.07	0.23	0.09	0.26	
H x G			0.11	0.36	0.13	0.42	
H x D			0.11	0.32	0.12	0.37	
G x D			0.13	0.40	0.15	0.46	
H x G x D			0.18	0.56	0.21	0.64	

Main plot- Methods of harvesting (H)
H_1: Mechanical harvesting
H_2: Manual harvesting

Sub plot - Genotype (G)
G_1: DGGV-2
G_2: DGG-1
G_3: Nirmal (popular local variety)

Sub sub plot- Defoliator chemical (D)
D_1: Paraquat @ 4ml l^{-1}
D_2: Control
NS= Non-significant

more compared to manual method of harvesting. Similar results were observed by Ozcan and Zeren (1987); Kalsirislip and Singh (1999); Padmanathan *et al.* (2006); Zhang *et al*. (2012) and Somanagouda (2013).

The interaction of methods of harvesting, genotypes and paraquat spray recorded significant difference with respect to seed yield. Among the interaction effects, irrespective of varieties mechanical harvesting with paraquat spray recorded higher yield (1337-1245 kg ha^{-1}) compared to mechanical harvesting without paraquat (911 - 990 kg ha^{-1}) because the control plot recorded higher harvest losses like threshing loss of about 56.4%, damaged grains about 44.68%, unthreshed pods about 55.29 % compared to paraquat sprayed plots. The similar results recorded by Thakar and Brar (2000) and Keith (2000).

Interaction of manual harvesting, varieties, with paraquat spray did not show any significant effect on yield. The result indicated that the paraquat spray did not have any vital role on manual harvesting.

Conclusion:

The grain recovery in combined harvester was increased by application of paraquat, which intern reduced the pre and post-harvest losses and saved the time and labour. Application of paraquat @ 4 mll^{-1}, three to four days before harvest reduced the moisture levels in the stalk and leaves to greater extent, which led to increase in working efficiency of harvesting methods.

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