Indian Journal of Agricultural Sciences **80** (4): 335–7, April 2010

Effect of sowing method, growth retardant and intercropping on horsegram (*Macrotyloma uniflorum*) productivity*

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Received: 27 July 2009; Accepted: 20 December 2009

Key words: Aggressivity, Competitive ratio, Horsegram, Intercropping, Relative crowding co-efficient

Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] is an important rainy (*kharif*) season pulse crop of north-western Himalaya and southern part of India grown under rainfed conditions. It is under exploited legume rich in iron (Virk *et al*. 2006). The varieties available in the hilly regions of north-west Himalayas are 1.0 to 1.25 m in length. Stems are weak, therefore, it spreads on ground as creepers and fully covers the soil surface with dense canopy. Crop canopy is so dense that light and air cannot penetrate properly ground surface and lower canopy. Pods and leaves present on the lower parts do not develop properly and mostly fall down. Heavy rainfall and waterlogging conditions further aggravate the problem. These result in poor grain yield of horsegram. Providing support to horsegram crop through intercrops may helps in better aeration and light penetration to lower crop canopy. Higher income under intercropping of horsegram with maize (*Zea mays* L.) was reported by Reddy *et al*. (2005). Similarly, planting methods, like ridge sowing and zero-tillage (Blackshaw *et al*. 2007) and growth retardant may help to enhance pulses productivity. The information in these aspects is not available in horsegram under hill condition. Hence the study was planned to see the effect of supporting intercrop, sowing method and growth retardant on horsegram productivity.

A field experiment was conducted during rainy (*kharif*) season of 2005 and 2006 at the experimental farm, Hawalbagh (29º36′ N, 79º40′ W and 1 250 m above sea level) of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand. The area has a typical sub-tropical climate, with severe cold winter, hot and dry summer and rainy season. Average annual rainfall in the area is 1 020 mm/annum. The total rainfall received during rainy season of 2005 and 2006 was 797 and 580 mm, respectively. During *kharif* 2005 monsoon was late and hence therefore sowing was done by the end of June, whereas during 2006 well distributed good rainfall was received.

Soil was classified as sandy clay loam with slightly acidic in reaction (*p*H 6.2) and medium in organic carbon (0.5%) with low in available N (174 kg/ha), and medium in available P (11.2 kg/ha) and K (194 kg/ha). Promising varieties 'VL Gahat 1' of horsegram, 'Him 129' of maize, 'VL Madua 146' of finger millet (*Eleusine coracona* Gaertn), 'VL Arhar 1' of pigeonpea (*Cajanus cajan* L. Millsp.) and 'VL Madira 29' barnyard millet (*Echinochloa frumentacea* L.) were used for study. The experiment was laid out in randomized block design with 3 replications. The treatments consisted of recommended sowing on flat bed, ridge sowing, zero tillage sowing, growth retardant (maleic hydrazide), horsegram + maize (green cobs) (2:1), horsegram + finger millet (1:1), horsegram + pigeonpea, horsegram + barnyard millet (1:1) and sole crop of maize (green cobs), finger millet, pigeonpea and barnyard millet. Maleic hydrazide @ 50 ppm was applied twice at 30–35 days after sowing and at flowering stage. The crops were sown during first fortnight of June in both the years at a row spacing of 30 cm. One hand weeding was carried out at 25– 30 days after sowing. The recommended dose of fertilizers for horsegram 20, 17.6 and 16.6 kg NPK/ha was given to sole crop of horsegram and intercropping of horsegram with finger millet, pigeonpea and barnyard millet, while 90, 26.4 and 33.2 kg NPK/ha for sole crop of maize and 45, 13.2 and 16.6 kg NPK/ha for maize lines in intercrop with horsegram were applied. All the fertilizers were applied at the time of field preparation except in case of maize in which half dose of N was applied as basal and half in 2 split doses at knee-height stage and tasseling stage. The harvesting was done at maturity of each crop. Horsegram equivalent yield was worked out on the basis of existing market price of each crop. After harvesting the crop soil samples were taken from surface soil (0–15 cm) for analysis.

*Short note

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Table 1 Effect of different intercropping systems on competitive ratio, relative crowding co-efficient, aggressivity and land-equivalent ratio (mean of 2 years)

Treatment	Competitive ratio		Relative crowding co-efficient (RCC)			Aggressivity		LER
	Horsegram	Intercrop	Horsegram (Kw)	Intercrop (Ki)	System (K=Kw × Ki)	Horsegram	Intercrop	
Horsegram + maize	0.74	1.35	1.77	2.18	3.86	–0.40	0.40	1.29
Horsegram + finger millet	0.88	1.13	1.99	3.19	6.35	–0.19	0.19	1.39
Horsegram + pigeonpea	1.12	0.89	1.82	1.37	2.49	–0.10	0.10	1.21
Horsegram + barnyard millet	0.89	1.11	1.57	2.12	3.33	–0.14	0.14	1.26

The intercropping indices, viz competition ratio, crowding co-efficient, land equivalent ratio, aggressivity and monetary advantage were worked out to evaluate the treatment effects reciprocity functions for supporting intercropping system.

Significant improvement in grain yield of horsegram was recorded due to different sowing methods. The highest grain yield of horsegram was recorded in ridge sowing (1.11 tonnes/ha) which was at par with zero-tillage sowing (1.04 tonnes/ha) and significantly higher over recommended sowing (0.82 tonne/ha). The higher yield under ridge sowing and zero-tillage was attributed due to favourable growth and development. Improvement in grain yield of horsegram was also recorded under application of maleic hydrazide (0.93 tonne/ha) but it was not significantly higher over recommended practice. In case of intercropping systems horsegram yields were at par and significantly lower than the sole cropping of horsegram. Lower yield of horsegram under intercropping was mainly due to less area covered under horsegram in intercropping. Malik *et al.* (2006) had reported higher grain yield of pigeonpea and mungbean, respectively under ridge sowing and dry bean under zero tillage by Blackshaw *et al*. (2007). However, higher yield of cowpea with application of growth retardant due to delay in senescence of pods and leaves was reported by Resmi and Gopalakrishnan (2004).

Improvement in horsegram equivalent yield was observed due to intercropping as well as improved sowing methods and maleic hydrazide application. However, significantly highest horsegram equivalent yield (except sole maize) was recorded in intercropping of horsegram + maize (cobs) (1.75 tonnes/ha) which was at par with horsegram + finger millet (1.57 tonnes/ha) and significantly superior over rest of the treatments. In case of intercropping system, horsegram + pigeonpea also gave significantly superior horsegram equivalent yield (1.37 tonnes/ha) over the recommended flat bed sowing. The lowest horsegram equivalent yield was recorded with sowing in flat bed (0.82 tonnes/ha). Horsegram equivalent yield was also significantly higher in case of ridge sowing (1.11 tonnes/ha). Higher horsegram equivalent yield under horsegram + maize system was mainly due to higher return from maize (cobs) in comparison to other intercrops. However, in case of horsegram + finger millet higher equivalent yield was mainly due to higher yield of both crops in the system. Under sole cropping, maize gave the highest horsegram equivalent yield (2.23 tonnes/ha). This was mainly because of higher productivity and returns from maize. Higher value of wheat equivalent yield under wheat-based intercropping was reported by Srivastava and Bohra (2006).

Competitive ratio of horsegram was highest in case of horsegram + pigeonpea intercropping system (1.12) as compared to pigeonpea (0.89), whereas in other intercropping systems competitive ratio was higher under intercrops that showed the dominance of intercrops, viz maize, finger millet and barnyard millet over the horsegram in intercropping system (Table 1).

Relative crowding co-efficient of intercropping systems was higher than unity that showed the advantage of intercropping over sole cropping. The highest value of relative crowding co-efficient was obtained under horsegram + finger millet intercropping (6.35), followed by horsegram + maize (3.86) intercropping and lowest under horsegram + pigeonpea (2.49). This showed that horsegram + finger millet and horsegram + maize intercropping systems should be preferred over rest of 2 intercropping systems. The relative crowding co-efficient was higher under intercrops except in case of horsegram + pigeonpea. This showed the dominance of intercrops over horsegram.

Aggressivity values of intercropping and mixed cropping showed greater than zero indicating yield advantage over sole cropping. Aggressivity values were negative under horsegram and positive in case of intercrops (Table 1). The data revealed that in intercropping systems intercrops were dominant and horsegram was the dominated crops.

Intercropping of horsegram showed superiority over sole cropping in terms of land equivalent ratio (LER). Highest LER was obtained with horsegram + finger millet intercropping (1.39), followed by horsegram + maize (1.29) and lowest values was recorded in horsegram + pigeonpea intercropping (1.21).

Significant differences were observed in soil chemical properties except for available K (Table 2). Intercropping and zero tillage had shown improvement in soil properties over recommended and ridge sowing. Soil *p*H was significantly higher under zero tillage and horsegram +

Table 2 Effect of sowing method, growth regulator and intercropping on soil properties

Treatment	*p*H	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Sole maize	6.25	0.52	186.0	9.8	203.5
Sole finger millet	6.20	0.50	191.5	10.6	204.9
Sole pigeonpea	6.30	0.52	203.4	11.2	199.6
Sole barnyard millet	6.20	0.48	194.8	10.8	194.3
Sole horsegram (rec. sowing)	6.20	0.52	196.3	11.7	202.3
Ridge sowing	6.00	0.53	182.3	11.3	198.7
Maleic hydrazide @ 50 ppm	6.23	0.50	182.7	11.3	196.3
Zero tillage	6.50	0.64	215.0	13.8	216.0
Horsegram + maize (green cobs)	6.30	0.56	206.7	12.7	208.7
Horsegram + finger millet	6.40	0.61	218.3	12.4	216.3
Horsegram + pigeonpea	6.40	0.58	210.0	12.5	207.0
Horsegram + barnyard millet	6.50	0.60	207.7	12.8	213.3
SEm±	0.12	0.04	11.1	0.4	11.6
CD (*P*= 0.05)	0.25	0.09	23.7	0.9	NS

barnyard millet intercropping (6.5) over the recommended sowing (6.2) and ridge sowing (6.0). Similarly, organic carbon also showed highest value under zero tillage (0.64%), followed by horsegram + finger millet (0.61) and significantly higher over the recommended sowing (0.52%), ridge sowing (0.53%) and maleic hydrazide (0.5%). *p*H and organic carbon under all intercropping and zero tillage were at par. Zero tillage and intercropping of horsegram also showed improvement in available NPK. The highest available N (218.3 kg/ha) and K (216.3 kg/ha) were recorded under horsegram + finger millet and available P under zero tillage (13.8 kg/ha). However, the lowest values of available NPK were under ridge sowing and maleic hydrazide. Soil chemical values were lower under ridge sowing and maleic hydrazide might be due to higher leaching of nutrients in comparison to other treatments. Improvement in soil properties under intercropping system was also reported by Padhi and Panigrahi (2006).

SUMMARY

A field experiment was conducted during 2005 and 2006 at Almora to evaluate the sowing methods, maleic hydrazide and intercropping systems in horsegram. The study revealed that system productivity in terms of horsegram equivalent yield was highest under horsegram + maize (1.75 tonnes/ha), followed by horsegram + finger millet intercropping (1.57). Ridge sowing (1.11 tonnes/ha), zero tillage (1.04 tonne/ha) and maleic hydrazide (0.93) also gave higher yield over recommended sowing (0.83 tonne/ha). Competition indices like competitive ratio, relative crowding co-efficient, aggressivity and LER showed superiority of horsegram intercropping, over sole cropping. Relative crowding co-efficient (6.35) and LER (1.39) was highest under horsegram + finger millet intercropping, followed by horsegram + maize. Thus ridge sowing, zero-tillage, growth retardant and intercropping may enhance the horsegram productivity.

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